LEVEL

THE ICAPS WATER MASS HISTORY FILE

20000727248

MAY 1978

DEPARTMENT OF THE NAVY
NSTL STATION
BAY ST. LOUIS, MS 39522

(14) NOO-RP-19

(12)

(6) # THE ICAPS WATER MASS HISTORY FILE.

(9) Final reply

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(11) MAY 1978

(12) 79

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FOREWORD

The emergence of on-scene sonar prediction systems provides tactical support to Antisubmarine Warfare (ASW) forces far superior to that previously available. However, the usefulness of such systems is limited if they do not produce products representative of the environment. A shortcoming of previous systems is the failure to allow for dynamic changes in the deep oceanographic environment. This publication describes a historical oceanographic data file which provides for oceanographic variability. This file, which has undergone considerable testing, is presently a part of the ICAPS software developed at the Naval Oceanographic Office (NAVOCEANO).

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ACKNOWLEDGMENTS

Space does not permit recognition of all those who contributed to the creation of the water mass file since its inception several years ago. Among those providing substantial assistance were A. W. Ortolano and L. Riley (data processing); W. H. Beatty, III (evaluation); and I. Pelaez, D. L. Nicholson, and A. G. Voorheis (manuscript preparation). The task was funded as part of the ICAPS program under the control of the Naval Oceanographic Office.

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INTRODUCTION

Sound speed profiles extending from sea surface to ocean floor are a necessary input to sonar range prediction models. Because synoptic sound speed profiles rarely are available to fleet operating units, synthetic profiles are constructed either by combining a synoptic bathythermograph trace with deep historical oceanographic data (Mendenhall; Faucher, et al; Hanssen and Tucker), or by historical data alone (Russell, Podeszwa). Each of the several techniques available relies on a different method of generating the surface-to-bottom sound speed profiles. They agree, however, in that they provide a single seasonal profile for each region; with each region having fixed boundaries. Unfortunately, real-world oceanographic features are constrained only by bathymetric boundaries, and their position may vary rapidly as in the case of a Gulf Stream meander or cyclonic eddy. Thus historic files based upon a single regional history frequently provide misleading sonar range predictions. The purpose of this report is to describe a historic oceanographic data file for the Northern Hemisphere and Indian Ocean based on water mass concepts--in which the computer program uses the characteristics of the input bathythermograph trace to automatically select one of several possible histories. The file was designed to be incorporated into the Integrated Command Antisubmarine Warfare Prediction System (ICAPS).

Two assumptions were made while developing the new file: (1) that near surface water masses can be uniquely identified by thermohaline characteristics and (2) the thermal characteristics of neighboring water masses are sufficiently different as to permit reliable identification from an expendable bathythermograph (XBT) trace alone. After identification of the applicable deep history, temperature values of the input trace are merged with deep temperatures using an equation of the form

$$T_i = TH_i + K_i \, (K_{i-1} \, \Delta T) \qquad (1)$$

where T_i and TH_i are, respectively, estimated and historical temperatures at depth i, K a weighting factor, and ΔT the difference between temperature at the bottom of the XBT trace and interpolated historical temperature at the same depth. The weighting factor*, developed from empirical solution for a set of historical data, is determined as a function of the depth increment between points $(D_i - D_{i-1})$.

$$K_i = 0.835^{(D_i - D_{i-1})/100} \qquad (2)$$

At the first synthesized temperature value $(i = 1)$, K_{i-1} equals unity.

*Later evaluation of the merge showed that a constant of 0.700 created a more realistic merge in the Mediterranean Sea. The value of 0.835 was retained for all other areas.

PROCEDURE

Because few guidelines for water mass identification are available in classical oceanographic literature, it was decided that the most objective method of determining water mass characteristics within a given area was to review original oceanographic data. Two NAVOCEANO data files were available for this purpose: (1) an oceanographic station data file of approximately 491 thousand observations compiled by the National Oceanographic Data Center (NODC) provided temperature and salinity data at each of 32 standard depths between the sea surface and 7,000 meters (m), and (2) an XBT file of approximately 218 thousand observations compiled from three sources (NAVOCEANO, NODC, and the Fleet Numerical Weather Central) provided temperature data at each flexure point over the depth range of the instrument (as deep as 760 m). The following procedure was used to determine water mass characteristics in the near-surface layer (0-400 m):

a. The classical literature was searched for applicable descriptive papers. For example, the northern edge of the Gulf Stream is frequently delineated by the 15°C isotherm at 200 m.

b. The ocean station data file was used to provide annual composite statistical data (mean, standard deviation, number of observations) at each standard depth using all available data within the area of interest. A plot of the distribution of temperature versus salinity, plotted at both 200 and 400 m, provided insight as to the number of water masses present and thermohaline variability within each water mass. Figure 1 shows a plot of temperature versus salinity at 200 m in the rectangle 45 to 50°N, 40 to 50°W--an area where the cold Labrador Current meets with the warmer North Atlantic Drift. The presence of water masses with specific thermohaline characteristics is clearly recognizable, and tentative water mass classification has been made. The 200-m level was found to be a good depth for classification in that it is generally well below the level of both diurnal and seasonal changes while being within the depth range of XBT probes. The XBT file provided statistical data and histograms for temperature and temperature gradients at preselected depths to supplement the ocean station data when necessary.

c. Flexure points in the temperature-versus-salinity (T-S) plot shown in figure 1 clearly defined water mass criteria in areas where different water masses exist in close proximity. Considerable temperature variability also occurs in areas occupied by a single water mass, probably a result of dynamic events such as upwelling. Where variability of this nature was observed, two classifications ("warm" and "cold") were made to provide a better merge between XBT trace and history.

d. Temperature ranges (filters) at 200 m were developed to distinguish adjacent water masses based on information provided in the previous steps. Where adjacent water masses had similar temperature range at 200 m, they were differentiated by examination of the temperature

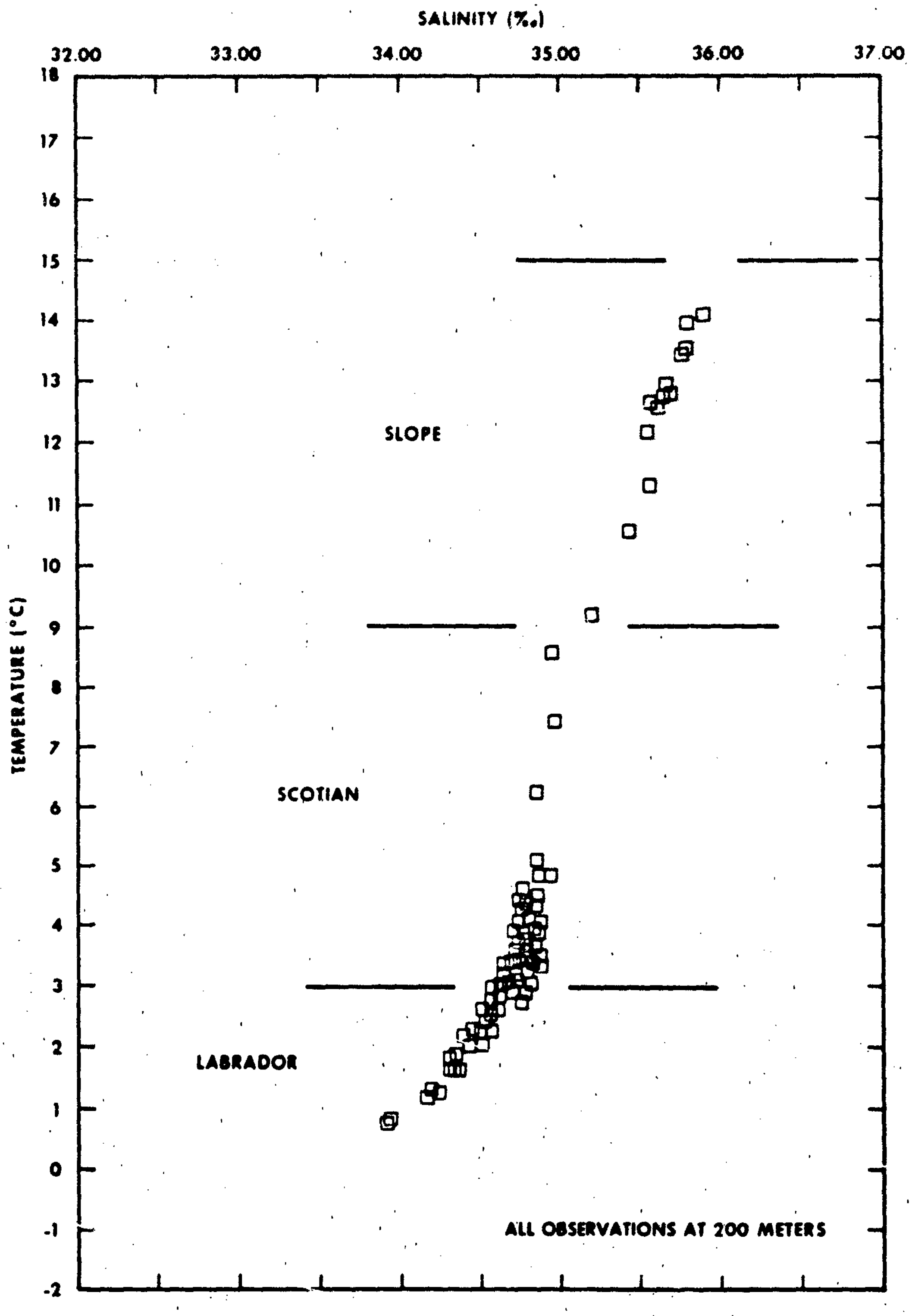


FIGURE 1. DISTRIBUTION OF TEMPERATURE VERSUS SALINITY, 45° - 50°N, 40° - 50°W.

gradient between the 200 and 300-m levels. For example, both the Gulf Stream and the Sargasso Sea are characterized by a temperature range of from 15 to 25°C at 200 m. A near-isothermal layer of 18°C water that extends from the bottom of the seasonal thermocline to depths exceeding 300 m in the Sargasso water in a region well removed from the Gulf Stream (30 to 35°N, 60 to 65°W), showed that 95 percent of the observations had a temperature gradient between 0.0°C/100 m and -1.6°C/100 m. Thus the gradient -1.6°/100 m at the 200-300 m level is used in the region of the Gulf Stream to differentiate Sargasso Water from Gulf Stream Water.

e. Mean seasonal temperature and salinity values were then determined for each depth and water mass (fig. 2). Where the data are not deep enough, temperature and salinity were extrapolated to the bottom by comparison with neighboring profiles. Inconsistencies in the data--such as a temperature inversion at depths below 200 m--were examined to determine if they are a result of statistical processing, data distribution, or bad data.

f. A quality control check was made by plotting the seasonal data on a single plot of temperature versus salinity (fig. 3). Inconsistencies in the data are immediately apparent; temperature errors by a vertical spike, salinity errors by a horizontal spike, and depth errors by a skewed spike. Where data were obviously incorrect, the plot was smoothed to conform with surrounding data. A second quality control check was made by visual inspection of seasonal traces of temperature and salinity versus depth. Discrepancies again were smoothed after comparison with neighboring traces.

EVALUATION

The file was evaluated by comparing the merged profile generated by both the new water mass file and the old file--which is based on a single seasonal profile for each 5-degree ocean rectangle--with new oceanographic data. Test data typical of each water mass within the test areas were selected from salinity-temperature-depth (STD) observations on file at either NODC or the Coast Guard Oceanographic Unit. Six observations per season, divided equally among water masses, were selected for each area. The uppermost portion (0-400 m) of the STD cast was treated as an XBT and the temperature trace extended to 1,500 m by merging with both old and new history files. Salinity was estimated and sound speed computed for all depths between the surface and 1,500 m. In the surface layer, estimated salinity and sound speed values were compared with observed values from the STD traces for each depth on the simulated XBT trace. In the deep layer (400-1,500 m) estimated temperature, salinity, and sound speed values were compared with observed values at 6 depths: 500, 600, 800, 1,000, 1,200, and 1,500 m.

The first test was designed to test the premise that quality controlled data from a large area--in this case, a 5 x 10-degree rectangle--would compare favorably with the smaller area without quality

DEPTH	TEMPERATURE			SALINITY		
	MEAN	S.D.	NUM	MEAN	S.D.	NUM
0	23.77	2.28	676	34.34	1.10	684
10	23.10	2.65	682	34.55	.97	680
20	21.72	3.70	682	34.84	.83	680
30	19.42	4.36	683	34.96	.83	679
50	15.87	4.17	683	35.14	.76	678
75	14.49	2.86	683	35.41	.55	678
100	13.78	2.04	683	35.54	.38	678
125	13.10	1.57	684	35.54	.28	678
150	12.54	1.34	684	35.51	.22	678
200	11.21	1.24	684	35.38	.17	676
250	9.86	1.23	684	35.24	.15	674
300	8.68	1.25	682	35.14	.13	674
400	6.87	1.10	582	35.03	.10	575
500	5.67	.79	551	34.99	.06	545
600	5.03	.52	529	34.98	.05	525
700	4.67	.32	518	34.98	.04	514
800	4.43	.24	473	34.97	.03	471
900	4.27	.20	438	34.97	.03	436
1000	4.13	.17	393	34.96	.03	386
1100	4.02	.15	350	34.96	.04	345
1200	3.92	.13	330	34.96	.04	324
1300	3.85	.12	322	34.96	.04	316
1400	3.78	.12	319	34.95	.04	313
1500	3.72	.12	315	34.95	.04	311
1750	3.56	.09	270	34.95	.04	264
2000	3.41	.09	239	34.95	.04	233
2500	3.00	.11	160	34.94	.03	154
3000	2.59	.16	89	34.92	.03	84
4000	2.26	.07	41	34.90	.02	[illegible]

SLOPE WATER (35-42N,60-76W) - SUMMER

TEMP RANGE = 9.00 - 15.00, SAL RANGE = 30.0 - 40.0

FIGURE 2. TEMPERATURE AND SALINITY AT STANDARD DEPTHS IN SLOPE WATER.

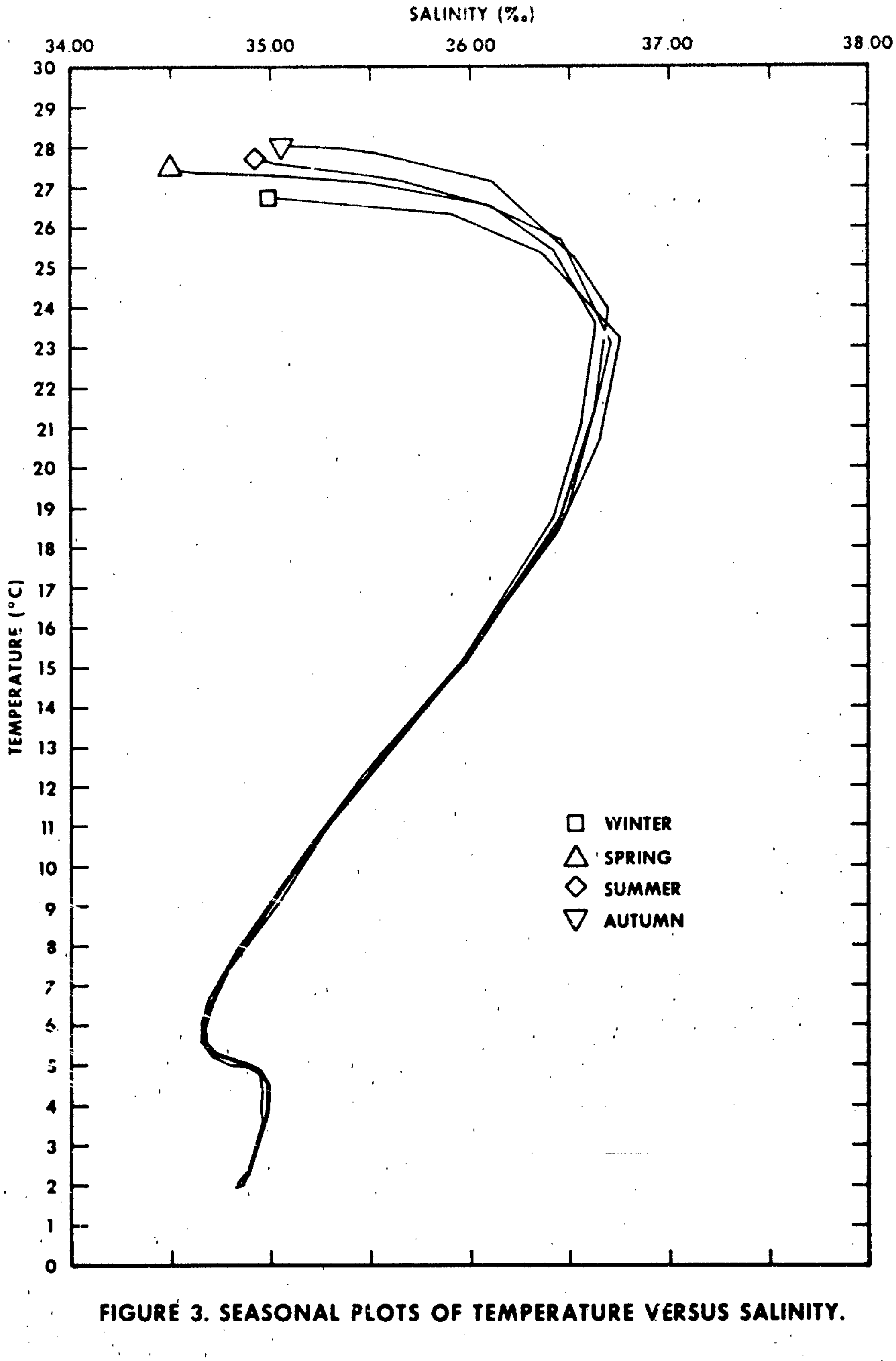


FIGURE 3. SEASONAL PLOTS OF TEMPERATURE VERSUS SALINITY.

LAYER/SEASON	N	TEMPERATURE (°C) OLD MEAN	OLD RMS	NEW MEAN	NEW RMS	SALINITY (o/oo) OLD MEAN	OLD RMS	NEW MEAN	NEW RMS	SOUND SPEED (m/s) OLD MEAN	OLD RMS	NEW MEAN	NEW RMS
Surface													
Winter	86					0.22	0.22	0.22	0.22	0.3	0.3	0.3	0.3
Spring	84					0.33	0.25	0.24	0.21	0.5	0.4	0.4	0.3
Summer	79					0.39	0.50	0.36	0.42	0.6	0.8	0.6	0.6
Autumn	79					0.27	0.10	0.24	0.16	0.4	0.1	0.3	0.2
Annual	328					0.30	0.31	0.26	0.28	0.4	0.5	0.4	0.4
Deep													
Winter	36	0.63	0.63	0.75	0.66	0.21	0.20	0.22	0.20	2.5	2.5	3.0	2.6
Spring	36	0.63	0.62	0.56	0.56	0.17	0.16	0.15	0.14	2.4	2.4	2.2	2.2
Summer	36	0.83	0.61	0.63	0.50	0.23	0.17	0.14	0.11	3.1	2.3	2.4	1.9
Autumn	36	0.76	0.70	0.69	0.69	0.16	0.16	0.17	0.16	2.9	2.7	2.6	2.6
Annual	144	0.71	0.65	0.66	0.61	0.19	0.18	0.17	0.16	2.7	2.5	2.6	2.4

Table 1. Mean and root mean square difference between observed values and estimated values, using former history (old) and water mass history (new), at OWS ECHO

LAYER/SEASON	N	TEMPERATURE (°C) OLD MEAN	TEMPERATURE (°C) OLD RMS	TEMPERATURE (°C) NEW MEAN	TEMPERATURE (°C) NEW RMS	SALINITY (o/oo) OLD MEAN	SALINITY (o/oo) OLD RMS	SALINITY (o/oo) NEW MEAN	SALINITY (o/oo) NEW RMS	SOUND SPEED (m/s) OLD MEAN	SOUND SPEED (m/s) OLD RMS	SOUND SPEED (m/s) NEW MEAN	SOUND SPEED (m/s) NEW RMS
Surface													
Winter	82					1.90	1.66	0.72	0.50	2.2	1.9	0.8	0.6
Spring	74					2.34	2.41	0.54	0.48	2.6	2.7	0.7	0.6
Summer	83					2.52	3.20	0.74	0.32	2.8	3.7	0.3	0.2
Autumn	95					1.53	1.09	0.42	0.36	1.8	1.3	0.5	0.4
Annual	334					2.05	2.83	0.60	0.44	2.3	2.6	0.7	0.5
Deep													
Winter	36	1.64	1.57	1.10	1.02	[illegible].50	0.45	[illegible]	0.19	6.0	5.8	4.0	3.7
Spring	36	1.56	1.49	1.80	1.70	0.32	0.32	0.28	0.25	6.0	5.7	7.0	6.6
Summer	36	1.32	1.01	1.40	1.19	0.17	0.16	0.17	0.16	5.1	4.0	5.3	4.5
Autumn	36	1.36	1.32	0.75	0.64	0.44	0.42	0.17	0.17	[illegible].1	4.9	2.8	2.4
Annual	144	1.47	1.37	1.26	1.26	0.36	0.38	0.21	0.20	5.6	5.2	4.8	4.8

Table 2. Mean and root mean square difference between observed values and estimated values, using former history (old) and water mass history (new), in the Virginia Capes area.

	N	SALINITY (o/oo)		SOUND SPEED (m/s)	
		MEAN	RMS	MEAN	RMS
Adjusted	57	0.58	0.49	0.8	0.7
Unadjusted	57	0.87	0.61	1.1	0.9

Table 3. Mean and root mean square difference between observed and estimated values with and without salinity adjustment in temperature inversions.

controlled data as used to compile the old history. Should this premise prove correct, then considerable reduction could be made in the file size. The area including Ocean Weather Station (OWS) ECHO (44°N, 48°W) was selected because considerable STD data were available from an area of relatively little oceanographic variability. The results of the test at OWS ECHO are given in table 1. The new water mass file provides slightly better results in both the surface and deep layers.

The second test was designed to document the ability of the new file to differentiate among water masses, thereby providing a merged profile superior to that produced by the old file. An area of high oceanographic variability seaward of the Virginia Capes (VACAPES) was selected because of the presence of three water masses: Slope Water, Gulf Stream Water, and Sargasso Water. Results of this test (table 2) show that the water mass file estimates salinity significantly better in the surface layer with a corresponding increase in the accuracy of sound speed computations. The deep data again are slightly better when estimated by the water mass file than with the old file.

The final test evaluated the ability of the water mass file to adjust salinity values in a near-surface temperature inversion (sound channel). Persistence of inversions for months at a time show that they are stable oceanographic features. However, use of unadjusted historical salinities must be reduced by the method given in Appendix A if they are to be realistic.

Salinity adjustment was evaluated in Slope Water in the VACAPES area where well-defined inversions occur from April through October. Salinity was estimated in an inversion using the water mass history first with and then without the adjustment routine and compared with observed values from 20 STD drops. Results of that evaluation--given in table 3--indicate that adjusted salinity values are more accurate than unadjusted values in temperature inversions.

FILE DESCRIPTION

The water mass file has been segmented to permit installation in computers of various storage capacity such as the (UNIVAC 1108, NOVA 800, and IBM 360). For example, the North Atlantic is divided into areas A through E, the North Pacific A through G, and the Indian Ocean A through D. Each area is further divided into regions of similar oceanographic properties, with the lowest denominator being a one-degree rectangle. A region may have as many as five water masses, but normally is limited to two or three. Historical data are provided by season, with winter consisting of January through March, et cetera. An exception to these seasons is found in the Indian Ocean, where the summer monsoon season is April through September, and the winter monsoon is October through March. Given the geographic position, data from an XBT trace, and season, the program will automatically select the proper water mass history for the merge.

The file order and temperature characteristics (temperature filter at 200 m, temperature difference between 200 and 300 m) of each water mass are given in Appendixes B through D. In the absence of real-time data, the user may want to make an ICAPS run on the basis of history alone. Therefore, the last column of each table provides the frequency of observance of each water mass within a region. The file is arranged so that water masses are listed by order of ascending temperatures; i.e., the coldest water at 200 m is in the first position of each region and the warmest is in the last position. The first position (coldest water) will automatically be selected by the computer when making a run using historical data unless the user specifies otherwise during the run set-up.

In certain instances, the use of the most frequently observed water mass may provide misleading results. Atlantic Area A (Appendix B) shows that slope water is the most frequently observed (58 percent) water mass in region A20. However, a task unit operating south of the Gulf Stream would require sonar range predictions based on Sargasso water instead of slope water. Although the frequency of slope water in region A20 is twice that of Sargasso water (58 to 28 percent), little or no slope water occurs in the southeastern corner of this region. Therefore, overlays are included for most water mass areas to show the coverage of the most frequently encountered water mass as a function of file position. Using the same example as above, the overlay shows that the most frequent water mass encountered near 37°N, 62°W is found in file position 4, which corresponds to Sargasso water. Because file position may represent different water masses in adjacent regions (file position 3 is slope water in Atlantic region B3 and drift water in region B4) these graphics should not be used to define water mass boundaries. Where an overlay is not provided, it may be assumed that file position 1 is most common.

Two methods for selecting historical data are described in the preceding paragraphs. To avoid confusion as to which should be used, the following suggestions are offered:

(1) In the absence of a major oceanic front such as the Gulf Stream in an area of where the frequency of one water mass far surpasses the others, the tabular listings should be used. Example: Atlantic region C5 is both distant from oceanic fronts and has a predominant water mass (Northeast Atlantic, 65 percent).

(2) In the presence of an oceanic front or where regional differences occur, the overlay should be used. Examples: Sargasso water in the southeastern corner of Atlantic region A20 is separated from slope water by the Gulf Stream; Campeche water hugs the coastline of Central America in Atlantic region D11.

TYPICAL XBT FILE

A supplemental file to ICAPS containing XBT traces typical of each water mass by month is in the process of being constructed. The traces, extracted from a historical file of approximately 288 thousand observations, are stored in the file by multiple sets of depth-temperature pairs from which the original XBT trace may be reconstructed. Criteria for the selection of a typical trace are sea surface temperature, sonic layer depth, and shape representative of water conditions existing within the water mass during the month specified. The intended purpose of this file is threefold: (1) to provide detailed information about the near-surface layer to assist planning of future naval operations, (2) to supplement real-time observations in areas where few data are available, and (3) to provide a quality control standard against which real-time data can be compared. These data are both more frequent (monthly versus seasonal) and present more detail in the near-surface layer (real features not lost through the averaging process) than the deep historical water mass file described earlier.

Although the quality control function of the typical XBT file is of considerable value, the user should be aware of the fact that the file cannot cover all possibilities. For example, a well-formed temperature inversion persists along the edge of the Continental Shelf of the eastern United States from early spring until late summer. This feature is not shown on the typical XBT traces for that period because it is not typical of the entire region. Thus the user must not eliminate data if the feature in question is feasible or is duplicated by other traces.

REFERENCES

Faucher, K. A., J. D. Pugh, and D. V. Hardman, Sound velocity profile synthesis techniques for the Acoustic Range Prediction System (ARPS), Naval Undersea Center, Technical Note 970, San Diego, 23p., 1973.

Hanssen, G. L. and W. B. Tucker, III, Interim Integrated Carrier Antisubmarine Warfare Prediction System (ICAPS) manual, (CP 642-B Computer System) (U), Naval Oceanographic Office, Reference Publication 10, Washington, DC, 100p., 1975. CONFIDENTIAL

Mendenhall, B. R., Design of a structure parameterization method for application to the three-dimensional analyses of ocean temperature, Meteorology International Incorporated, Final Report, Project M-156, Monterey, 57p., 1970.

Podeszwa, E. M., Sound speed profiles for the North Pacific Ocean, Naval Underwater Systems Center, Technical Document 5271, New London, 184p., 1976.

Russell, J. J., A technique to summarize sound speed data from the sea for application in acoustic propagation loss models, Naval Undersea Center, Technical Note 1553, San Diego, 504p., 1975.

APPENDIX A

SALINITY ADJUSTMENT

Oceanographic stability is a prime requisite for persistence of near-surface temperature inversion (sound channels), since unstable conditions will destroy an inversion through mixing in a relatively short period. In physical oceanography, stability is quantified by the change in density with respect to change in depth; stable conditions being denoted by an increase of density with increasing depth. Because density is a function of both temperature and salinity, it follows, a priori, that a salinity inversion must coincide with a temperature inversion if stability is to be maintained. Historical salinities, by definition, represent mean conditions and thus cannot cope with an anomalous condition such as an inversion. This appendix describes a method of adjusting salinity as estimated from a historical file to provide a stable water column. In order to allow for minor instabilities frequently observed in Arctic waters, the correction is only applied where a temperature inversion exceeds 0.25°C.

The equation used to adjust historical salinity was derived from stepwise regression of density as a function of salinity (30 to 40 o/oo) and constant temperature (10°C).

$$\rho = -1.26584\times10^{-1}+7.72412\times10^{-1}S+4.22003\times10^{-8}S^{4} \qquad \text{(A-1)}$$

Differentiation of equation (A-1) to give change of density with respect to change in salinity yields, after rearrangement, addition of a correction term to assure stability within the inversion, and conversion of density to the more conventional sigma-t yields:

$$\Delta S_i = \frac{\Delta\sigma_t-0.01}{0.7724+1.6880\times10^{-7}S_o^{3}} \qquad \text{(A-2)}$$

Where $\Delta\sigma_t$: the difference between σ_t at adjacent points,

S_o : original historical salinity at point i

The initial step in applying equation (A-2) is the computation of sigma-t as a function of depth and temperature as input from the XBT and interpolated historical salinity. The XBT trace is scanned from bottom to top and salinity values are adjusted for all points within temperature inversions that are more than the temperature maximum minus 0.25°C at the lower boundary of the inversion. An adjustment of 0.01 sigma-t units is added to the numerator to assure stability within the inversion. Adjusted historical salinity (S_i) is now computed using the equation

$$S_i = S_o + \Delta S_i \qquad \text{(A-3)}$$

APPENDIX B
WATER MASS DEFINITION
NORTH ATLANTIC OCEAN/MEDITERRANEAN SEA

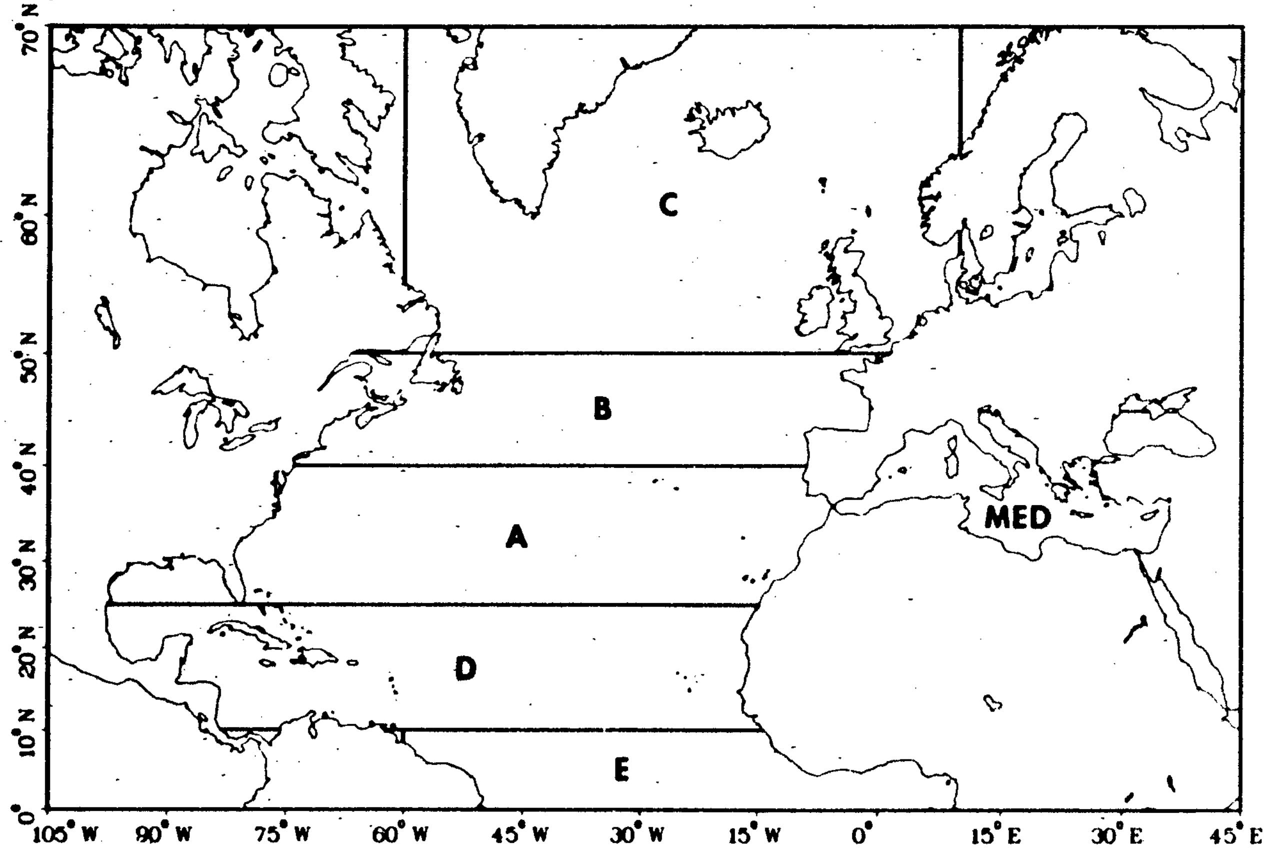
This appendix presents area definition and the thermal characteristics of each water mass within the file for the North Atlantic Ocean and the Mediterranean Sea. Subsequent appendixes cover the North Pacific and Indian Oceans. Each segment is divided into areas designated by letter (e.g., Atlantic A, Pacific A or Indian A). Within each segment, geographic regions of similar oceanic properties are designated by number (Atlantic All, Pacific A3 or Indian A2). Although as many as five water masses may occur in each region, most regions normally are restricted to one or two. For example, region All includes three water masses: Southern Slope, Stream, and Sargasso. It should be noted that large water masses, such as the Sargasso Sea, may cover several regions. Regions, water mass names, temperature range at 200 m (temperature filter), temperature difference between 200 and 300 m (DT) where applicable, file position, and frequency of observation of each water mass are provided in tabular form for each segment.

Water mass classification should be made initially using temperature at the 200 m level. When two water masses have similar temperature characteristics at this level, the temperature difference between 200 and 300 m (DT) should be used as a tiebreaker. The ICAPS computer will automatically select the appropriate history from season, position, and thermal characteristics of the input XBT trace.

Water mass names represent geographic features associated with the area and may not agree with classical oceanographic terminology. Where more than one water mass is found in a region, the user may wish to make ICAPS runs for only the most frequently observed water mass--therefore, overlays that depict the most frequently observed water mass by file positions are provided. The numbers on these correspond with the numbers in the tabular regional listings. In the absence of an overlay, the user may assume that a majority of observations are represented by the water mass in file position 1.

APPENDIX B

CONTENTS



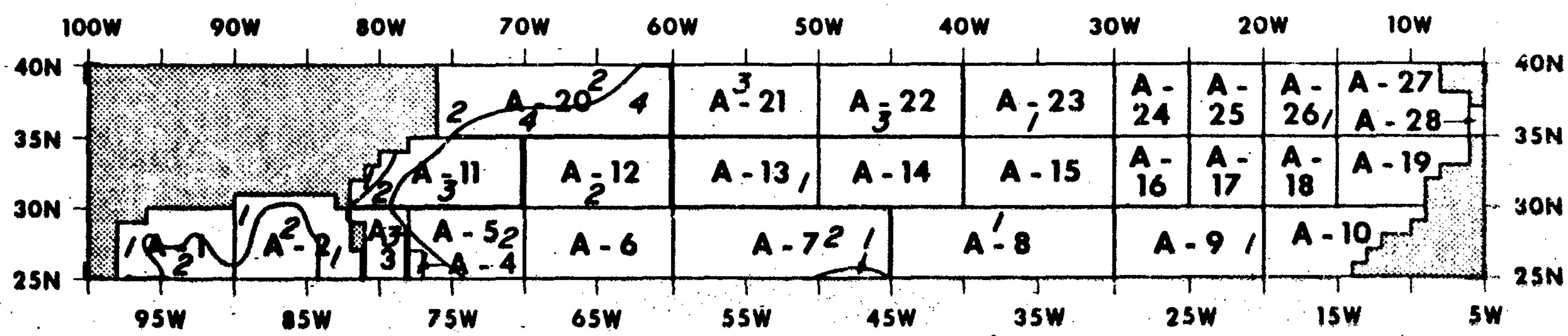
NORTH ATLANTIC OCEAN/MEDITERRANEAN SEA LOCATOR CHART.

ATLANTIC AREA A

Region	Water Mass Name	T200 (°C) Min	T200 (°C) Max	DT (°C) Min	DT (°C) Max	Position	Freq. (%)
A1	W. GULF	10	15			1	46
	W. LOOP	15	25			2	54
A2	E. GULF	10	15			1	39
	E. LOOP	15	25			2	61
A3	SO. SLOPE	9	15			1	8
	COLD WALL	15	17			2	15
	FLORIDA CURRENT	17	25	-8.0	-1.6	3	59
	SARGASSO	17	25	-1.6	0.0	4	18
A4	G. ANTILLES	15	26	-8.0	-1.6	1	77
	SARGASSO	15	25	-1.6	0.0	2	23
A5	G. ANTILLES	15	25			1	100
A6	ANTILLES C.	15	25	-8.0	-1.6	1	24
	SARGASSO	15	25	-1.6	0.0	2	76
A7	ANTILLES C.	15	22	-8.0	-1.6	1	8
	SARGASSO	15	22	-1.6	0.0	2	92
A8	ATLANTIC CENTRAL	15	22			1	100
A9	S.E. LANT	13	20			1	100
A10	S.E. LANT	12	18			1	100
A11	SO. SLOPE	9	15			1	8
	STREAM	15	25	-8.0	-1.6	2	29
	SARGASSO	15	25	-1.6	0.0	3	63
A12	STREAM	15	25	-8.0	-1.6	1	2
	SARGASSO	15	25	-1.6	0.0	2	98
A13	SARGASSO	15	25			1	100

Region	Water Mass Name	T200 (°C) Min	T200 (°C) Max	DT (°C) Min	DT (°C) Max	Position	Freq. (%)
A14	Atlantic Central	13	25			1	100
A15	N.E. LANT	12	20			1	100
A16	N.E. LANT	12	18			1	100
A17	N.E. LANT	12	18			1	100
A18	S.W. GIBRALTAR	12	20			1	100
A19	S.E. GIBRALTAR	12	20			1	100
A20	SCOTIAN	6	9			1	3
	SLOPE	9	15			2	58
	STREAM	15	25	-8.0	-1.6	3	13
	SARGASSO	15	25	-1.6	0.0	4	26
A21	SLOPE	9	15			1	13
	STREAM	15	25	-8.0	-1.6	2	8
	SARGASSO	15	25	-1.6	0.0	3	79
A22	TRANSITION	8	13			1	1
	DRIFT	13	25	-8.0	-1.6	2	3
	ATLANTIC CENTRAL	13	25	-1.6	0.0	3	96
A23	N.E. LANT	10	18			1	100
A24	N.E. LANT	12	18			1	100
A25	N.E. LANT	12	18			1	100
A26	N.W. GIBRALTAR	10	18			1	100
A27	N.E. GIBRALTAR	10	18			1	100
A28	ATLANTIC	11	15	-6.0	-0.2	1	11
	GIBRALTAR	11	15	-0.2	0.0	2	89

ATLANTIC AREA A

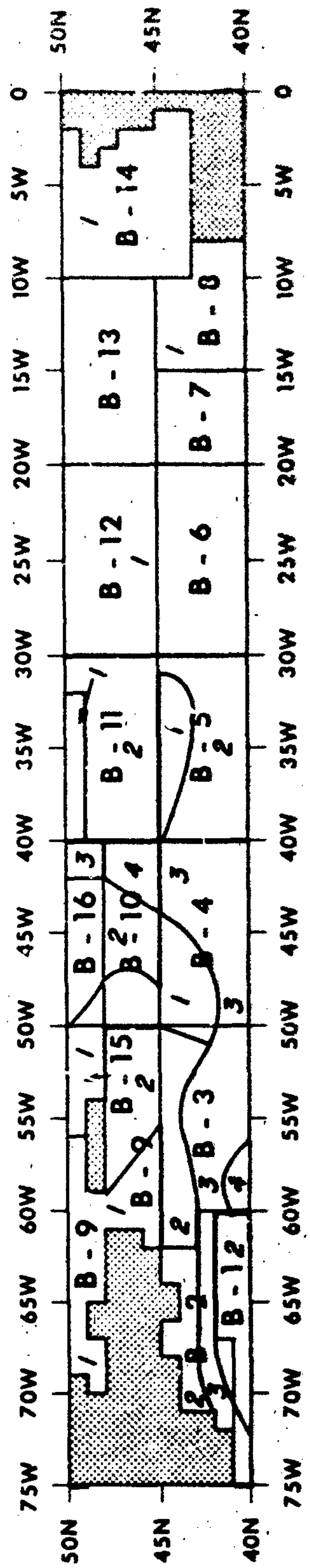


ATLANTIC AREA B

Region	Water Mass Name	T200 (°C) Min	T200 (°C) Max	DT (°C) Min	DT (°C) Max	Position	Freq. (%)
B1	SCOTIAN	6	9			1	9
	SLOPE	9	15			2	76
	STREAM	15	25	-8.0	-1.6	3	9
	SARGASSO	15	25	-1.6	0.0	4	6
B2	MODIFIED LAURENTIAN	3	6			1	9
	SCOTIAN	6	9			2	28
	SLOPE	9	15			3	63
B3	LAURENTIAN	-2	6			1	11
	GRAND BANKS	6	9			2	12
	SLOPE	9	15			3	50
	STREAM	15	25			4	27
B4	LABRADOR MIXED	3	9			1	24
	TRANSITION	9	13			2	10
	DRIFT	13	25			3	66
B5	DRIFT	11	14			1	48
	N.E. ATLANTIC	14	20			2	52
B6	N.E. ATLANTIC	11	18			1	100
B7	N.E. ATLANTIC	9	15			1	100

Region	Water Mass Name	T200 (°C) Min	T200 (°C) Max	DT (°C) Min	DT (°C) Max	Position	Freq. (%)
B8	N.E. ATLANTIC	9	15			1	100
B9	LAURENTIAN	-2	5			1	77
	GRAND BANKS	6	9			2	23
B10	LABRADOR	-2	3			1	28
	DAVIS STRAIT	3	8			2	66
	TRANSITION	8	12			3	2
	DRIFT	12	20			4	4
B11	TRANSITION	5	11			1	21
	DRIFT	11	18			2	79
B12	N.E. ATLANTIC	10	18			1	100
B13	N.E. ATLANTIC	9	15			1	100
B14	BISCAY	9	15			1	100
B15	LABRADOR	-2	3			1	84
	DAVIS STRAIT	3	12			2	16
B16	LABRADOR	-2	3			1	24
	DAVIS STRAIT	3	7			2	72
	TRANSITION	7	15			3	4

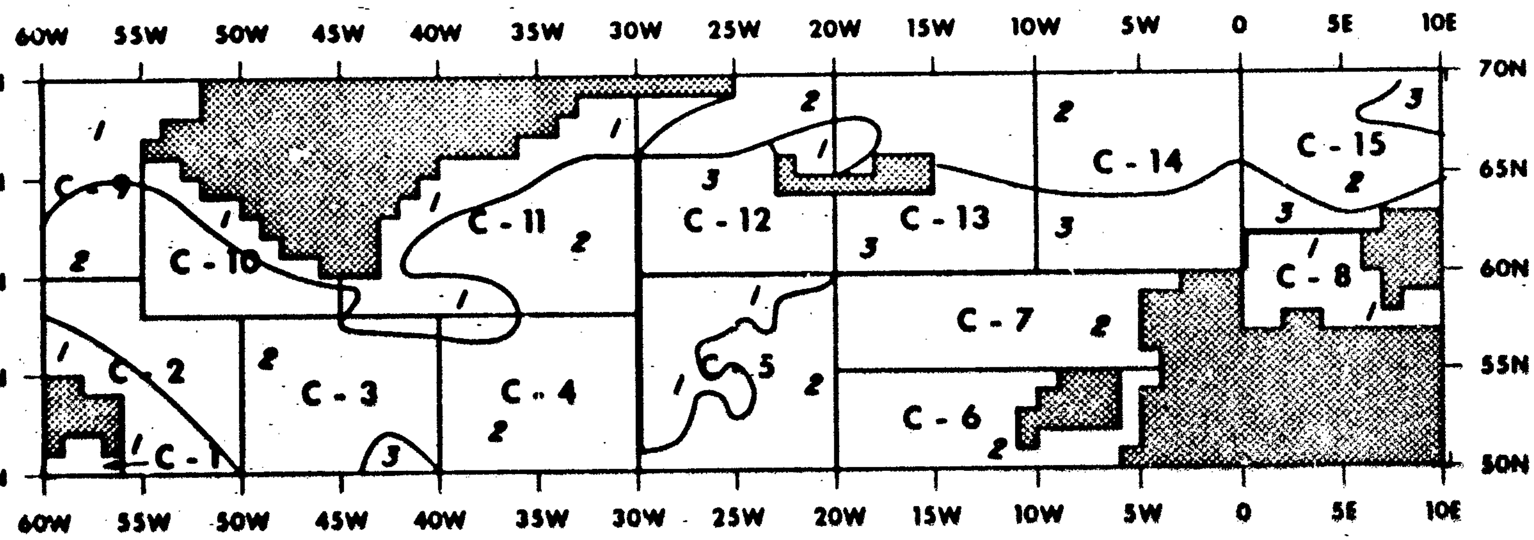
ATLANTIC AREA B



ATLANTIC AREA C

Region	Water Mass Name	T200 (°C) Min	T200 (°C) Max	DT (°C) Min	DT (°C) Max	Position	Freq. (%)
C1	LAURENTIAN	-2	6			1	77
	GRAND BANKS	6	9			2	23
C2	LABRADOR	-2	3			1	14
	DAVIS STRAIT	3	12			2	86
C3	LABRADOR	-2	3			1	7
	DAVIS STRAIT	3	7			2	82
	TRANSITION	7	15			3	11
C4	EAST GREENLAND	-2	5			1	19
	IRMINGER	5	12			2	81
C5	IRMINGER	5	9			1	35
	NORTHEAST ATLANTIC	9	13			2	65
C6	NORTHEAST ATLANTIC	8	15			1	100
C7	NORTHEAST ATLANTIC	7	12			1	100
C8	BALTIC OUTFLOW	4	11			1	100
C9	LABRADOR	-2	3			1	56
	DAVIS STRAIT	3	10			2	44
C10	WEST GREENLAND	-2	3			1	31
	DAVIS STRAIT	3	12			2	69
C11	EAST GREENLAND	-2	5			1	32
	IRMINGER	5	12			2	68
C12	MIXED	-2	5	-8.0	-1.2	1	19
	WEST ICELANDIC	-2	5	-1.2	3.0	2	5
	IRMINGER	5	12			3	76
C13	POLAR FRONT	-2	5	-8.0	-1.2	1	9
	EAST ICELANDIC	-2	5	-1.2	3.0	2	39
	NORTH ATLANTIC	5	12			3	52
C14	POLAR FRONT	-2	5	-8.0	-1.2	1	10
	EAST ICELANDIC	-2	5	-1.2	3.0	2	37
	NORWEGIAN SEA	5	12			3	53
C15	POLAR FRONT	-2	5	-8.0	-1.2	1	10
	EAST ICELANDIC	-2	5	-1.2	3.0	2	11
	NORWEGIAN SEA	5	12			3	79

ATLANTIC AREA C

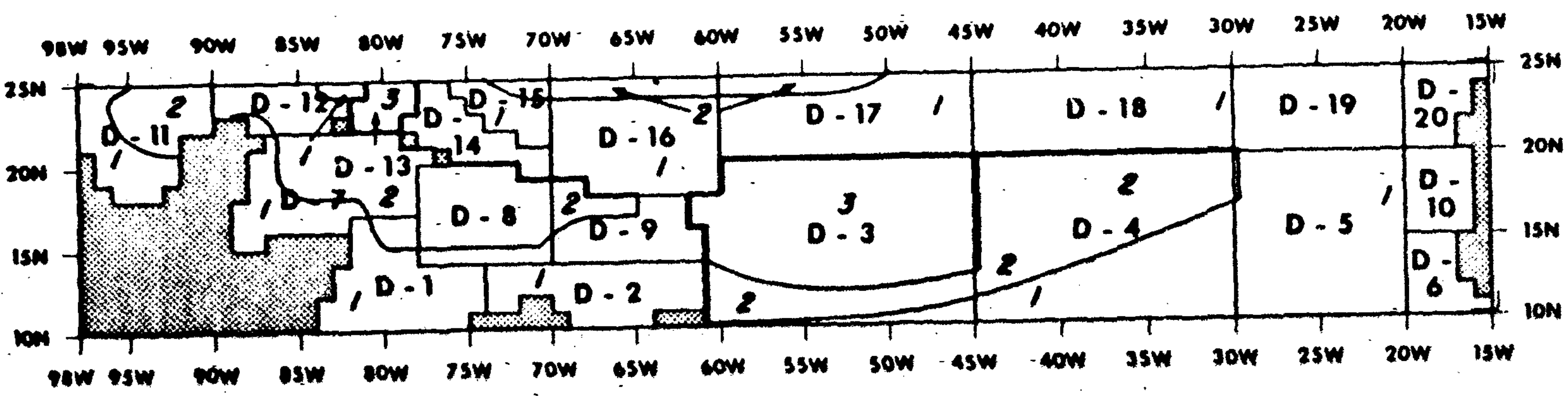


ATLANTIC AREA B

Region	Water Mass Name	T200 (°C) Min	T200 (°C) Max	DT (°C) Min	DT (°C) Max	Position	Freq. (%)
D1	COLOMBIAN	10.0	20.0			1	84
	WEST CARIBBEAN	20.0	30.0			2	16
D2	VENEZUELAN	10.0	20.0			1	100
D3	N.E. BRAZIL	9.0	13.0			1	8
	ANTILLES MIXED	13.0	17.0			2	35
	ANTILLES	17.0	21.0			3	57
D4	TROPOLANT	9.0	15.0			1	58
	ATLANTIC CENTRAL	15.0	25.0			2	42
D5	S.E. ATLANTIC	10.0	18.0			1	100
D6	S.E. ATLANTIC	10.0	15.0			1	100
D7	COLOMBIAN	10.0	20.0			1	41
	WEST CARIBBEAN	20.0	30.0			2	59
D8	CARIBBEAN COOL	10.0	20.0			1	27
	CENTRAL CARIBBEAN	20.0	30.0			2	73
D9	CARIBBEAN COOL	10.0	20.0			1	71
	EAST CARIBBEAN	20.0	30.0			2	29
D10	S.E. ATLANTIC	10.0	16.0			1	100
D11	CAMPECHE	10.0	15.0			1	34
	WEST LOOP	15.0	25.0			2	66

Region	Water Mass Name	T200 (°C) Min	T200 (°C) Max	DT (°C) Min	DT (°C) Max	Position	Freq. (%)
D12	EAST GULF	10.0	15.0			1	23
	EAST LOOP	15.0	25.0			2	77
D13	SOUTH SLOPE	9.0	15.0			1	2
	COLD WALL	15.0	17.0			2	4
	FLORIDA CURRENT	17.0	25.0	-8.0	-1.6	3	90
	SARGASSO	17.0	25.0	-1.6	0.0	4	4
D14	GREATER ANTILLES	15.0	25.0			1	100
D15	ANTILLES CURRENT	15.0	25.0	-8.0	-1.6	1	77
	SARGASSO	15.0	25.0	-1.6	0.0	2	23
D16	ANTILLES CURRENT	15.0	25.0	-8.0	-1.6	1	88
	SARGASSO	15.0	25.0	-1.6	0.0	2	12
D17	ANTILLES CURRENT	15.0	22.0	-8.0	-1.6	1	24
	SARGASSO	15.0	22.0	-1.6	0.0	2	76
D18	ATLANTIC CENTRAL	15.0	22.0			1	100
D19	S.E. ATLANTIC	13.0	20.0			1	100
D20	S.E. ATLANTIC	10.0	18.0			1	100

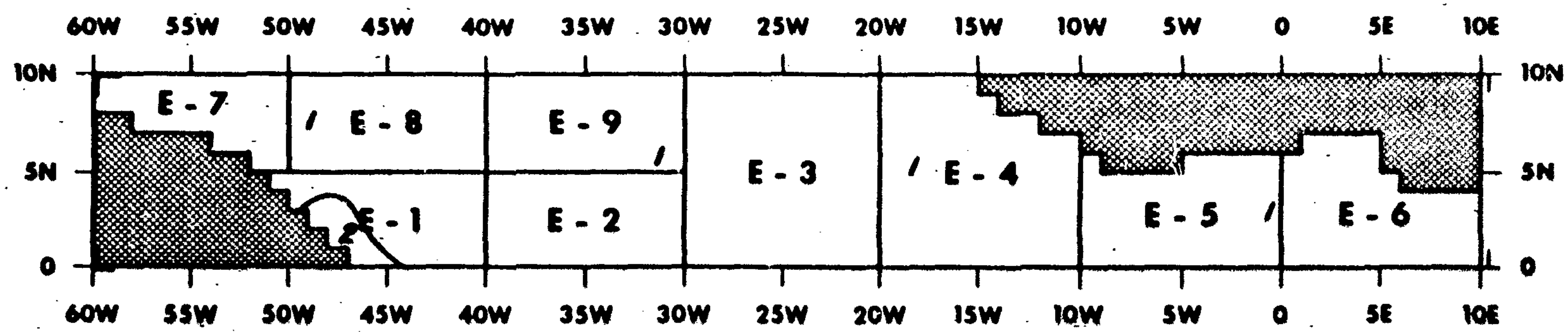
ATLANTIC AREA B



ATLANTIC AREA E

Region	Water Mass Name	T200 (°C) Min	T200 (°C) Max	DT (°C) Min	DT (°C) Max	Position	Freq. (%)
E1	TROPOLANT	8.0	14.0			1	65
	EQUALANT	14.0	22.0			2	35
E2	TROPOLANT	8.0	16.0			1	100
E3	S.E. ATLANTIC	10.0	16.0			1	100
E4	S.E. ATLANTIC	10.0	16.0			1	100
E5	S.E. ATLANTIC	11.0	19.0			1	100
E6	GULF OF GUINEA	11.0	19.0			1	100
E7	TROPOLANT	8.0	14.0			1	100
E8	TROPOLANT	8.0	14.0			1	96
	EQUALANT	14.0	22.0			2	4
E9	TROPOLANT	8.0	14.0			1	100

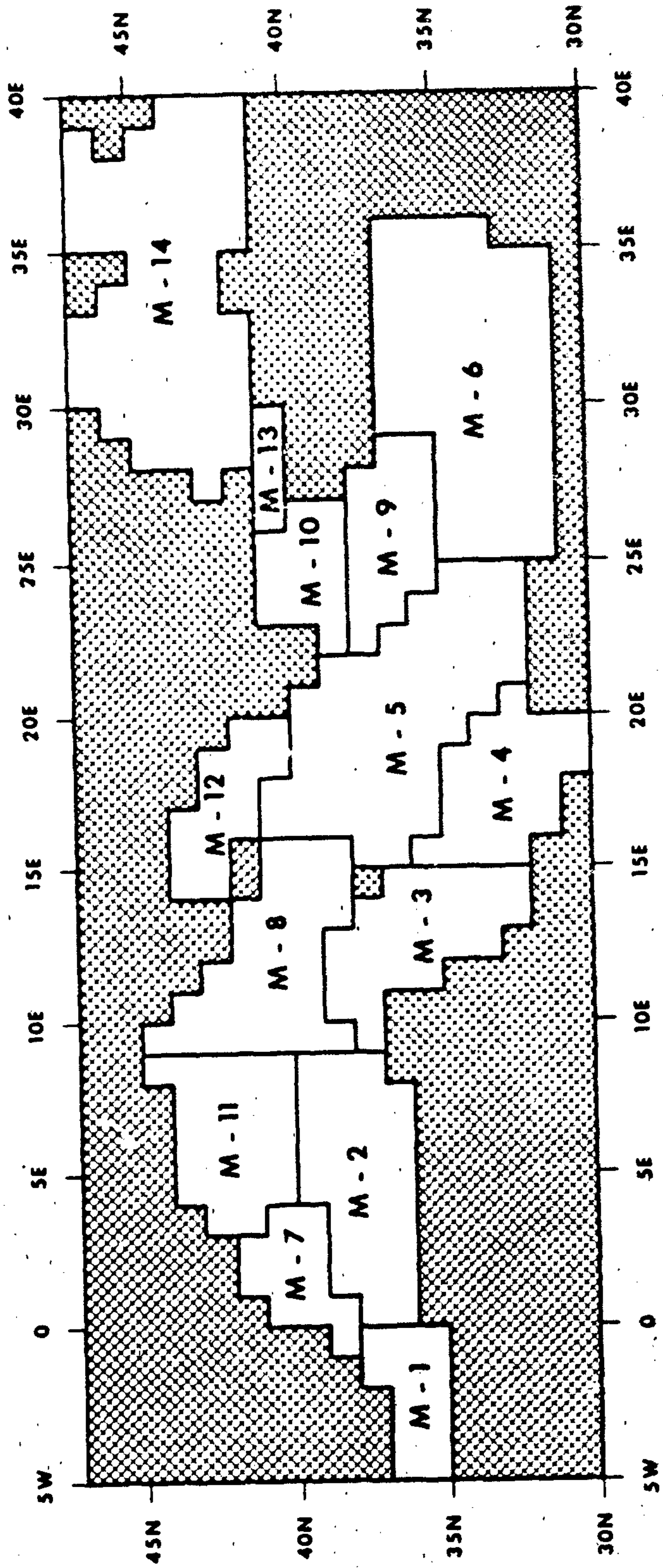
ATLANTIC AREA E



MEDITERRANEAN

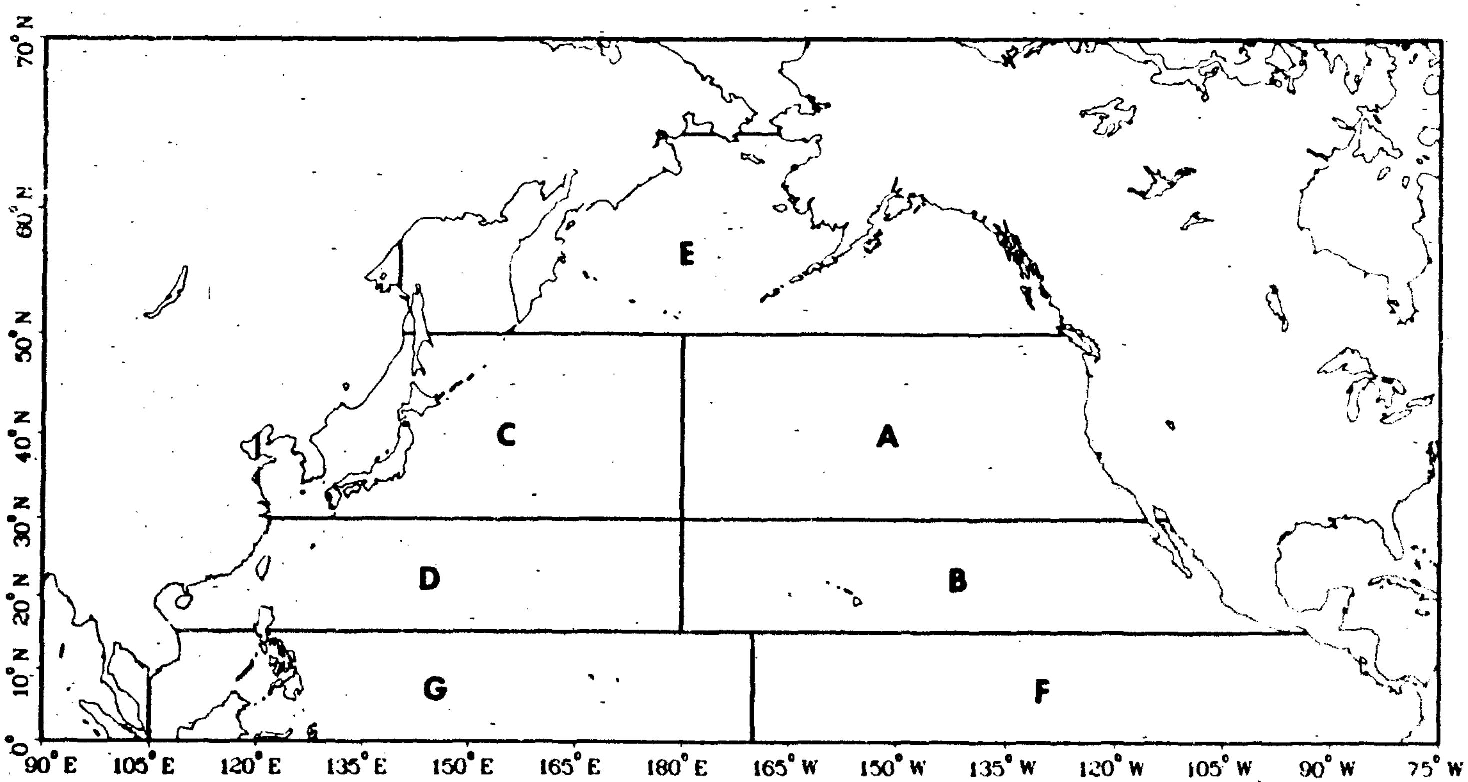
Region	Water Mass Name	T200 (°C) Min	T200 (°C) Max	DT (°C) Min	DT (°C) Max	Position	Freq. (%)
M1	ATLANTIC	11	15	-6.0	-0.2	1	11
	GIBRALTAR	11	15	-0.2	0.1	2	89
M2	ATLANTIC	11	15	-6.0	-0.2	1	13
	ALGERIAN	11	15	-0.2	0.1	2	87
M3	MALTESE	13	18			1	100
M4	LIBYAN	13	18			1	100
M5	IONIAN	13	13			1	100
M6	EAST MED	13	20			1	100
M7	ALBORAN	11	15			1	100
M8	TYRRHENIAN	12	15			1	100
M9	SOUTH AEGEAN	12	18			1	100
M10	NORTH AEGEAN	11	17			1	100
M11	LIGURIAN	11	16			1	100
M12	ADRIATIC	12	16			1	100
M13	MARMARA	12	16			1	100
M14	BLACK SEA	6	10			1	100

MEDITERREAN



APPENDIX C
NORTH PACIFIC OCEAN
(See Appendix B for explanation)

CONTENTS

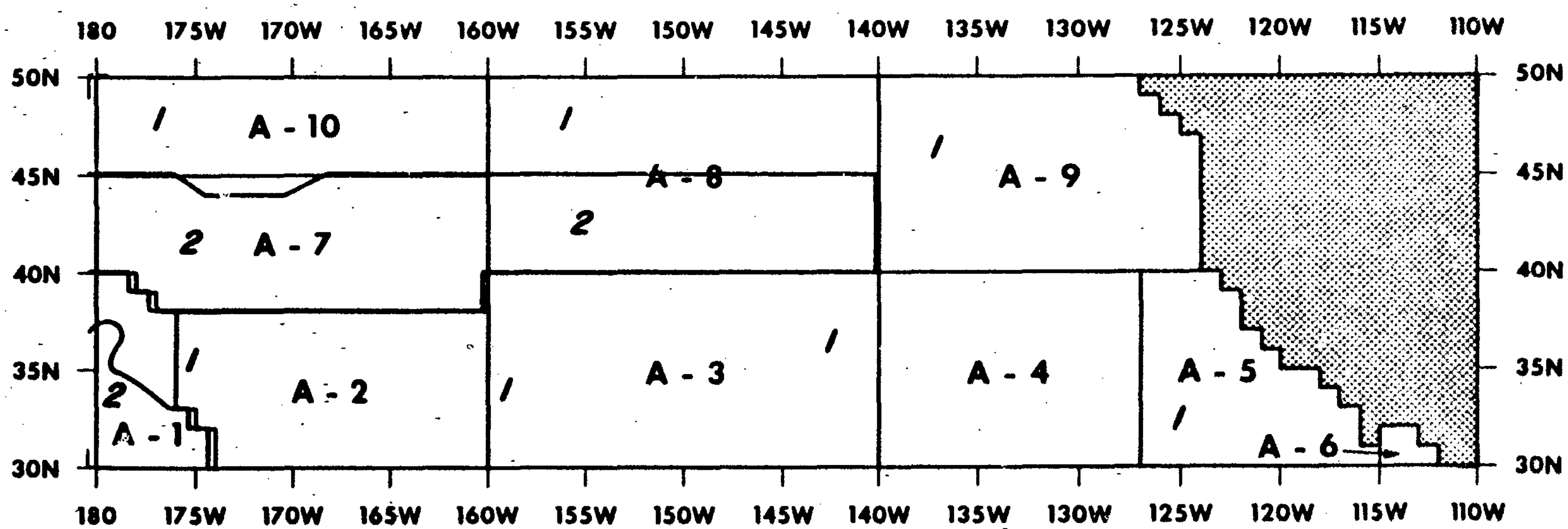


NORTH PACIFIC OCEAN LOCATOR CHART.

PACIFIC AREA A

Region	Water Mass Name	T200 (°C) Min	T200 (°C) Max	DT (°C) Min	DT (°C) Max	Position	Freq. (%)
A1	TRANSITION	7	13			1	35
	KUROSHIO	13	19			2	65
A2	EAST TRANSITION	10	16			1	100
A3	NORPAC	7	12			1	43
	EAST TRANSITION	12	16			2	57
A4	CALIFORNIAN	5	11			1	60
	EAST TRANSITION	11	19			2	40
A5	CALIFORNIAN	5	11			1	100
A6	GULF OF CALIFORNIA	10	18			1	100
A7	ALEUTIAN	0	7			1	8
	NORPAC	7	[illegible]			2	92
A8	ALASKAN	0	7			1	46
	NORPAC	7	12			2	54
A9	ALASKAN	0	9			1	100
A10	ALEUTIAN	0	6			1	100

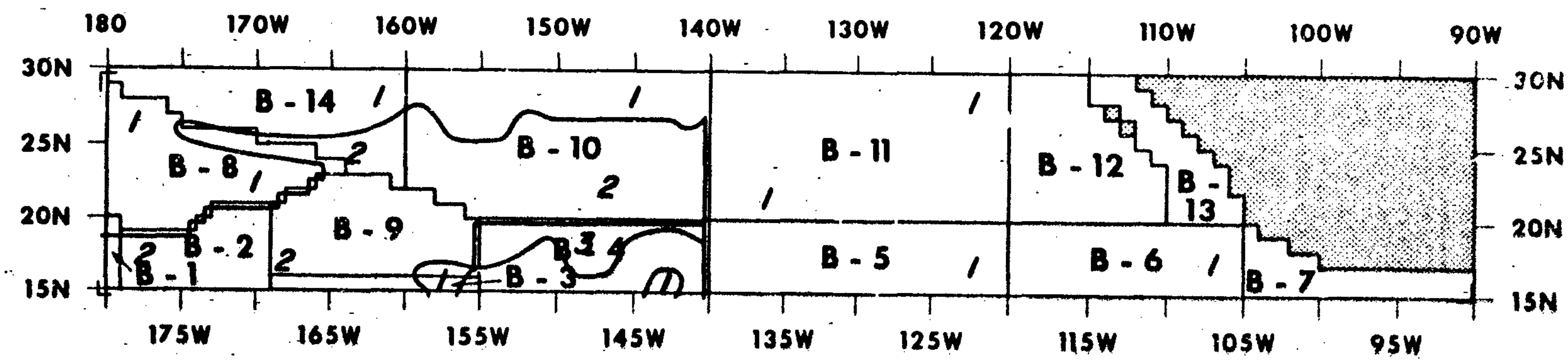
PACIFIC AREA A



PACIFIC AREA B

Region	Water Mass Name	T200 (°C) Min	T200 (°C) Max	DT (°C) Min	DT (°C) Max	Position	Freq. (%)
B1	MARSHALLS	8	17			1	30
	CENTRAL	17	26			2	70
B2	N. EQUAPAC	9	14			1	1
	E. CENTRAL	14	21			2	99
B3	N. EQUAPAC	8	14			1	22
	E. CENTRAL	14	20			2	78
B4	N.E. EQUAPAC	8	12			1	8
	E. CENTRAL	12	16			2	52
	S.E. HAWAIIAN	16	24			3	40
B5	N.E. EQUAPAC	8	15			1	100
B6	N.E. EQUAPAC	9	14			1	93
	GULF OUTFLOW	14	22			2	7
B7	N.E. EQUAPAC	9	14			1	98
	GULF OUTFLOW	14	22			2	2
B8	CENTRAL	13	21			1	100
B9	E. TRANSITION	10	16			1	19
	S.W. HAWAIIAN	16	23			2	81
B10	E. TRANSITION	11	16			1	38
	N.E. HAWAIIAN	16	23			2	62
B11	E. TRANSITION	10	18			1	100
B12	BAJA CALIFORNIA	6	13			1	100
B13	GULF OF CALIFORNIA	10	18			1	100
B14	E. TRANSITION	11	16			1	64
	N.W. HAWAIIAN	16	22			2	36

PACIFIC AREA B

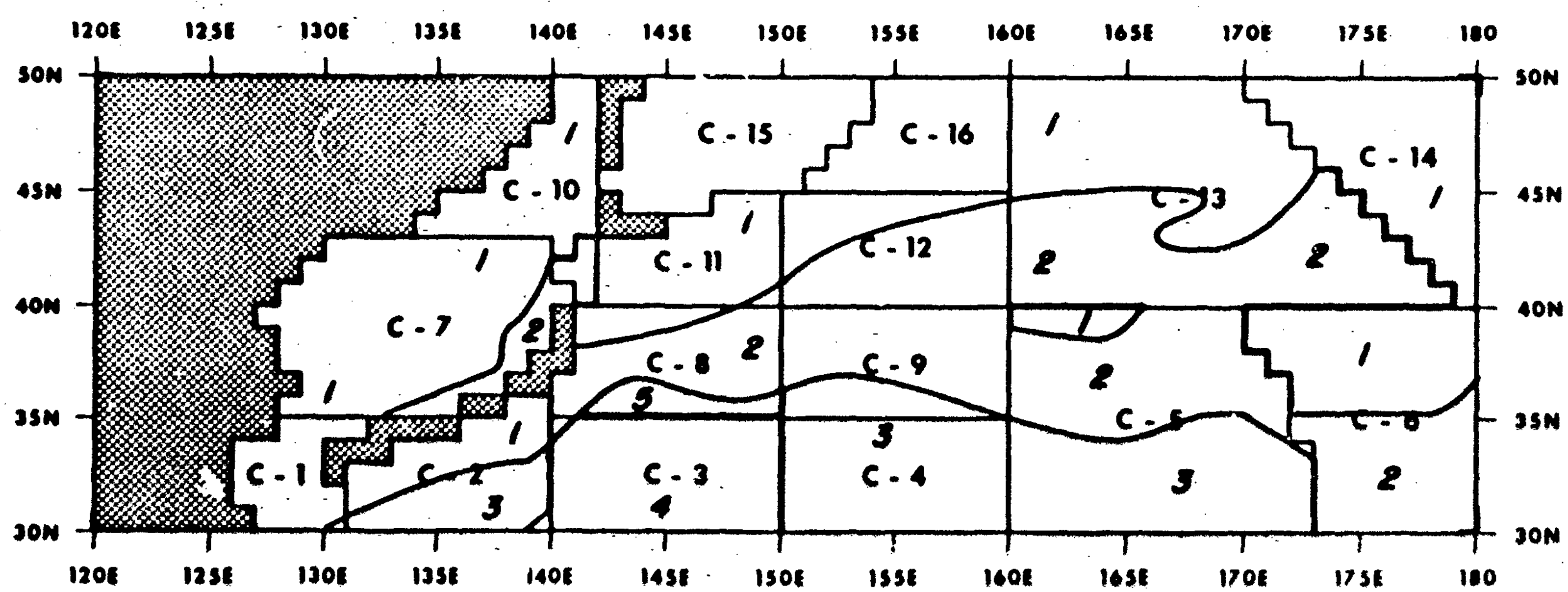


PACIFIC AREA C

Region	Water Mass Name	T/200 (°C) Min	T/200 (°C) Max	DT (°C) Min	DT (°C) Max	Position	Freq. (%)
C1	N. KOREAN	10	16			1	83
	TSUSHIMA	16	22			2	17
C2	[illegible]	8	15			1	46
	KUROSHIO	13	23	-8.0	-3.0	2	11
	N.W. CENTRAL	13	23	-3.0	0.0	3	43
C3	OYASHIO	5	11			1	4
	W. TRANSITION	11	15			2	11
	KUROSHIO	15	26	-8.0	-3.0	3	7
	N.W. CENTRAL	15	26	-3.0	0.0	4	78
C4	W. TRANSITION	6	15			1	16
	KUROSHIO	15	22	-8.0	-3.0	2	13
	N.W. CENTRAL	15	22	-3.0	0.0	3	71
C5	OYASHIO	[illegible]	10			1	3
	TRANSITION	[illegible]	14			2	38
	KUROSHIO	[illegible]	20			3	59
C6	TRANSITION	7	13			1	30
	KUROSHIO	13	19			2	70
C7	N. KOREAN	-2	3.5			1	71
	JAPAN CENTRAL	3.5	8			2	21
	S. KOREA	8	15			3	8
C8	KURILE	-2	5			1	20
	OYASHIO	5	10			2	37
	W. TRANSITION	10	13			3	17
	KUROSHIO	13	20	-8.0	-3.0	4	8
	N.W. CENTRAL	13	20	-3.0	0.0	5	18

Region	Water Mass Name	T/200 (°C) Min	T/200 (°C) Max	DT (°C) Min	DT (°C) Max	Position	Freq. (%)
C9	OYASHIO	2	8			1	18
	W. TRANSITION	8	12			2	59
	KUROSHIO	12	18			3	21
C10	LIMAN	-2	3.5			1	83
	JAPAN CENTRAL	3.5	8			2	17
C11	KURILE	-2	3.5			1	66
	OYASHIO	3.5	8			2	27
	W. TRANSITION	8	12			3	7
C12	KURILE	-2	3.5			1	40
	OYASHIO	3.5	10			2	60
C13	KURILE	0	5			1	23
	OYASHIO	5	13			2	77
C14	KURILE	-2	6			1	100
C15	OKHOTSK	-2	4			1	100
C16	KURILE	-2	6			1	100

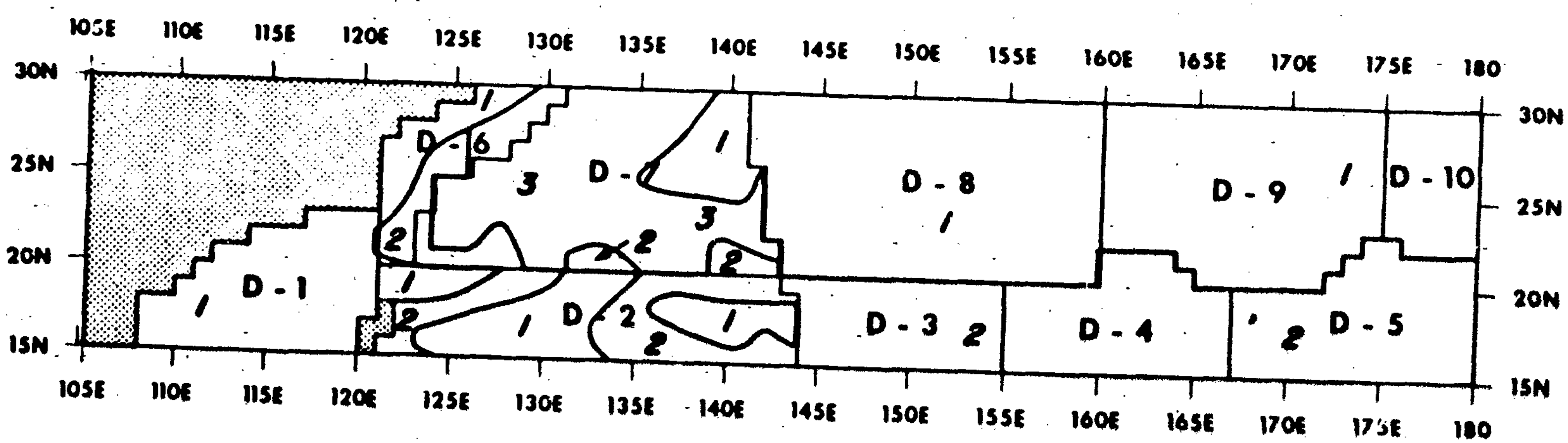
PACIFIC AREA C



PACIFIC AREA D

Region	Water Mass Name	T200 (°C) Min	T200 (°C) Max	DT (°C) Min	DT (°C) Max	Position	Freq. (%)
D1	S. CHINA COLD	11	17			1	96
	S. CHINA WARM	17	22			2	4
D2	LUZON	12	20			1	56
	W. CENTRAL	20	26			2	44
D3	N.W. MARIANAS	12	19			1	30
	W. CENTRAL	19	26			2	70
D4	E. MARIANAS	10	17			1	6
	W. CENTRAL	17	26			2	94
D5	MARSHALLS	8	17			1	16
	CENTRAL	17	26			2	84
D6	TAIWAN	12	18			1	39
	KUROSHIO	18	26	-8.0	-3.0	2	32
	N.W. CENTRAL	18	26	-3.0	0.0	3	29
D7	TAIWAN	12	18			1	28
	KUROSHIO	18	26	-8.0	-3.0	2	11
	N.W. CENTRAL	18	26	-3.0	0.0	3	61
D8	CENTRAL	12	24			1	100
D9	CENTRAL	12	24			1	100
D10	CENTRAL	13	21			1	100

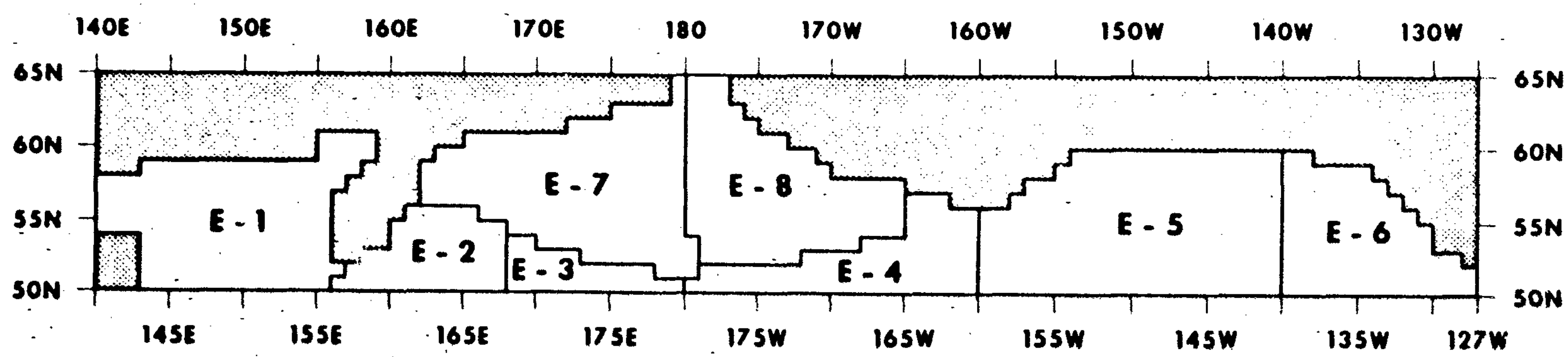
PACIFIC AREA B



PACIFIC AREA E

Region	Water Mass Name	T200 (°C) Min	T200 (°C) Max	DT (°C) Min	DT (°C) Max	Position	Freq. (%)
E1	OKHOTSK	-2	4			1	100
E2	KURILE	-2	6			1	100
E3	KURILE	-2	6			1	100
E4	ALEUTIAN	0	6			1	100
E5	ALEUTIAN	0	8			1	100
E6	ALASKAN	0	9			1	100
E	W. BERING	-2	6			1	100
E8	E. BERING	-2	6			1	100

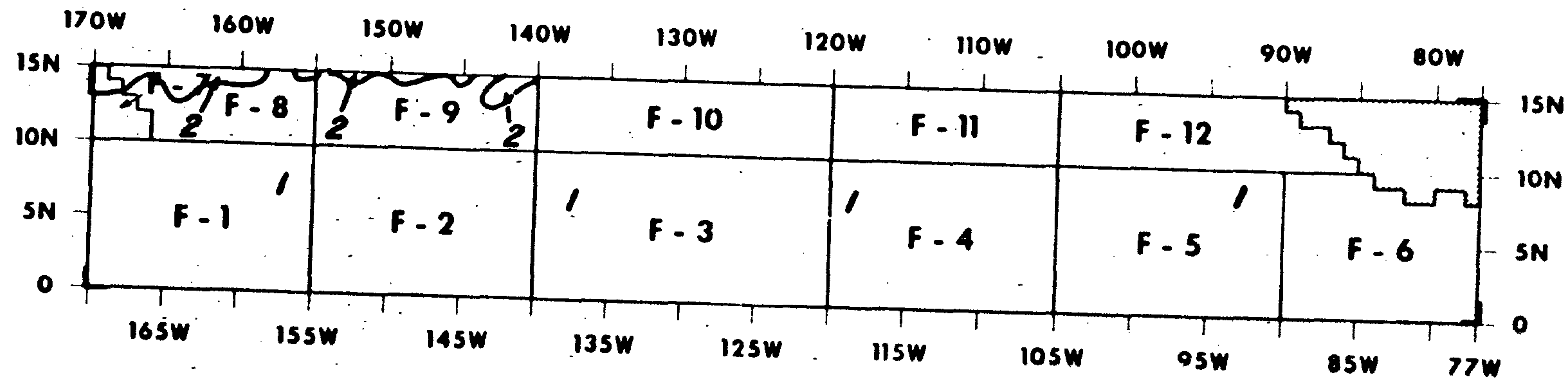
PACIFIC AREA E



PACIFIC AREA F

Region	Water Mass Name	T200 (°C) Min	T200 (°C) Max	DT (°C) Min	DT (°C) Max	Position	Freq. (%)
F1	N. EQUAPAC	8	14			1	19
	E. CENTRAL	14	20			2	81
F2	N.E. EQUAPAC	9	14			1	82
	E. CENTRAL	14	20			2	18
F3	N.E. EQUAPAC	9	15			1	100
F4	N.E. EQUAPAC	9	15			1	100
F5	GALAPAGOS	10	16			1	100
F6	PANAMA	10	15			1	100
F7	N. EQUAPAC	9	14			1	75
	E. CENTRAL	14	21			2	25
F8	N. EQUAPAC	9	13			1	77
	E. CENTRAL	13	20			2	23
F9	N.E. EQUAPAC	8	12			1	83
	E. CENTRAL	12	16			2	15
	S.E. HAWAIIAN	16	24			3	2
F10	N.E. EQUAPAC	8	15			1	100
F11	N.E. EQUAPAC	9	14			1	97
	GULF OUTFLOW	14	22			2	3
F12	N.E. EQUAPAC	9	14			1	99
	GULF OUTFLOW	14	22			2	1

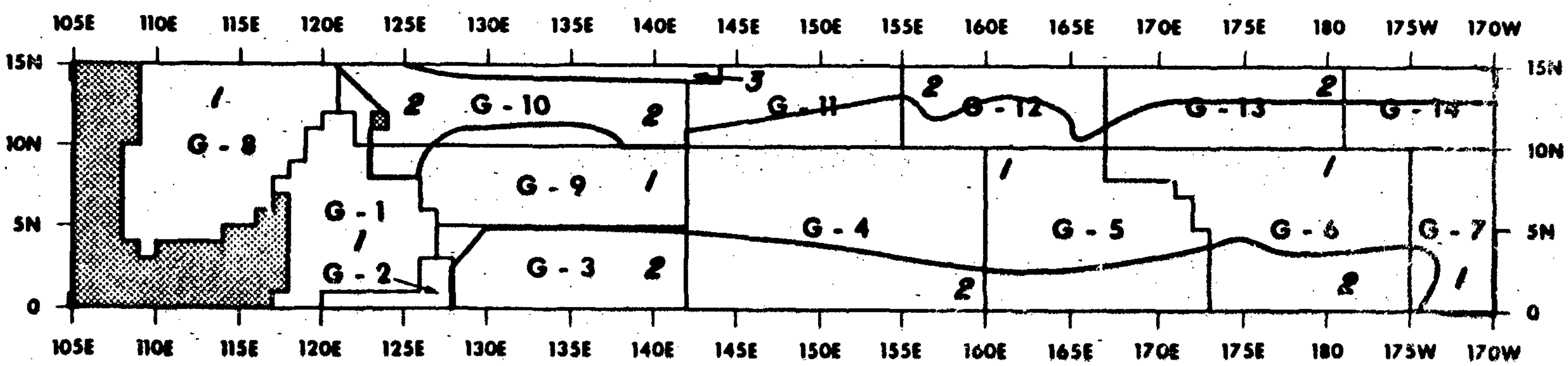
PACIFIC AREA F



PACIFIC AREA G

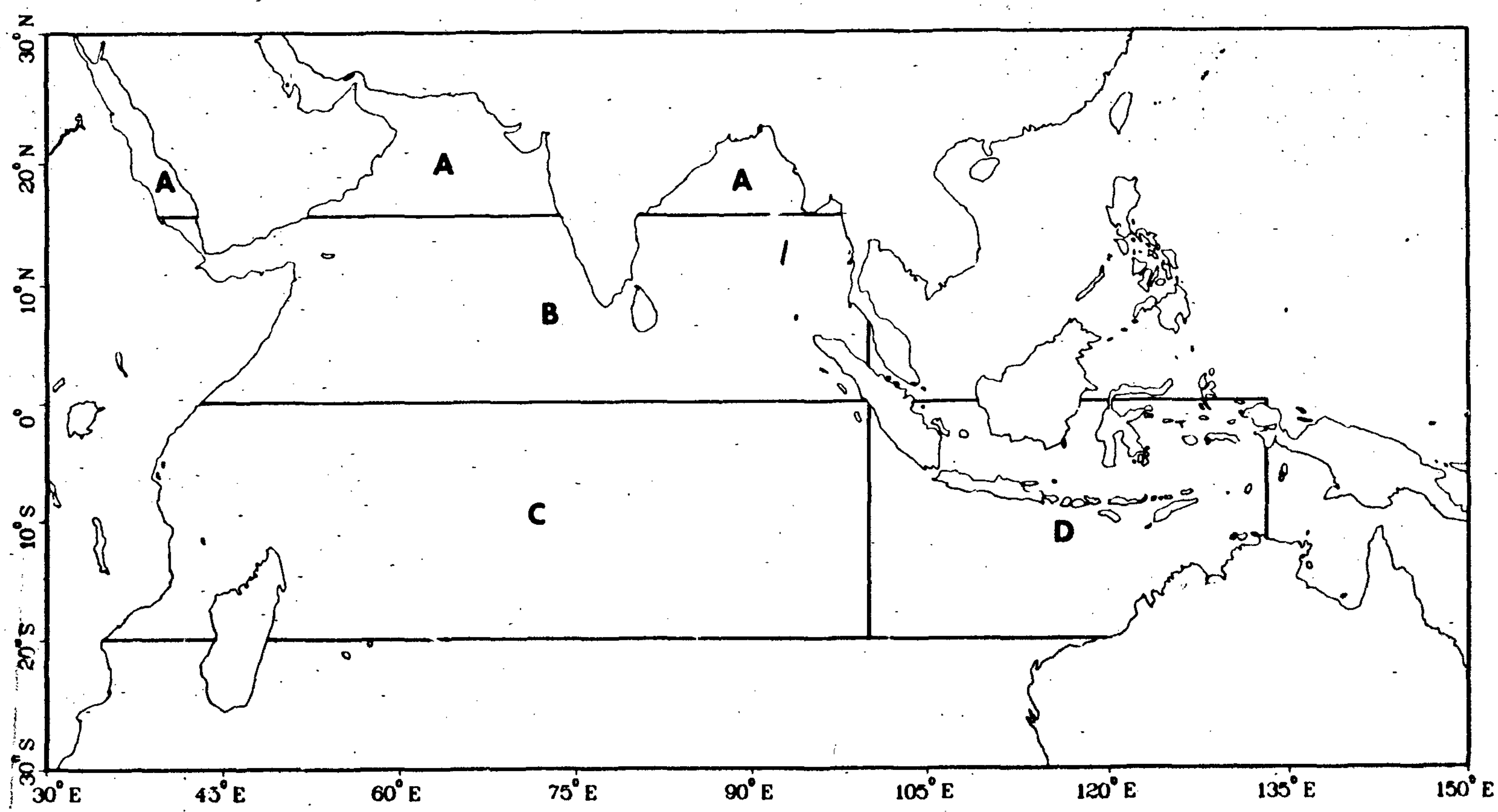
Region	Water Mass Name	T200 (°C) Min	T200 (°C) Max	DT (°C) Min	DT (°C) Max	Position	Freq. (%)
G1	SULU/CELEBES	13	21			1	100
G2	MOLUCCA	12	21			1	100
G3	MINDANAO	8	15			1	16
	N.W. EQUAPAC	15	25			2	84
G4	CAROLINE	8	16			1	62
	N.W. EQUAPAC	16	26			2	38
G5	MELANESIAN	8	15			1	56
	N. EQUAPAC	15	26			2	44
G6	TROPAC	6	14			1	68
	N. EQUAPAC	14	24			2	32
G7	N. EQUAPAC	8	14			1	76
	E. CENTRAL	14	20			2	24
G8	S. CHINA COLD	12	19			1	100
G9	MINDANAO	8	15			1	84
	N.W. EQUAPAC	15	25			2	16
G10	MINDANAO	8	15			1	15
	SAMAR	15	20			2	64
	W. CENTRAL	20	26			3	21
G11	S.W. MARIANAS	12	18			1	44
	W. CENTRAL	18	25			2	56
G12	E. MARIANAS	10	17			1	66
	W. CENTRAL	17	26			2	34
G13	MARSHALLS	8	17			1	68
	CENTRAL	17	26			2	32
G14	N. EQUAPAC	9	14			1	42
	E. CENTRAL	14	21			2	58

PACIFIC AREA 6



APPENDIX C
INDIAN OCEAN
(See Appendix B for explanation)

CONTENTS



INDIAN OCEAN LOCATOR CHART.

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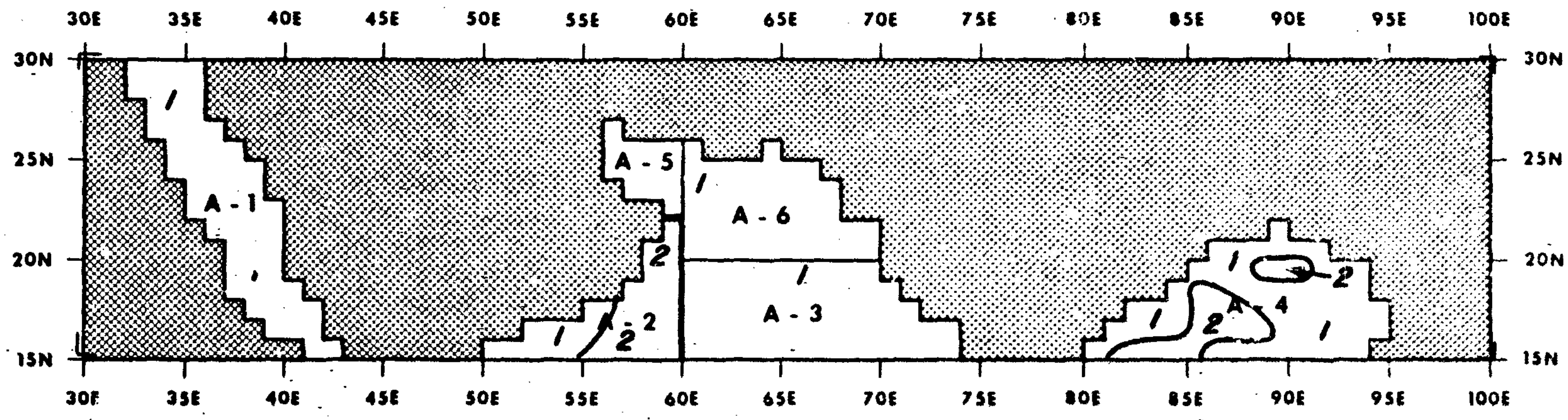
INDIAN AREA A

Region	Water Mass Name	T200 (°C) Min	T200 (°C) Max	DT (°C) Min	DT (°C) Max	Position	Freq. (%)
A1	RED SEA	19	26			1	100
A2	YEMEN COOL	12	16			1	36
	YEMEN WARM	16	21			2	64
A3	ARABIAN	12	19			1	100
A4	NORTH INDIAN COLD	11	15			1	72
	NORTH INDIAN WARM	15	20			2	28
A5	GULF OF OMAN	16	22			1	100
A6	PAKISTAN I	15	22			1	100

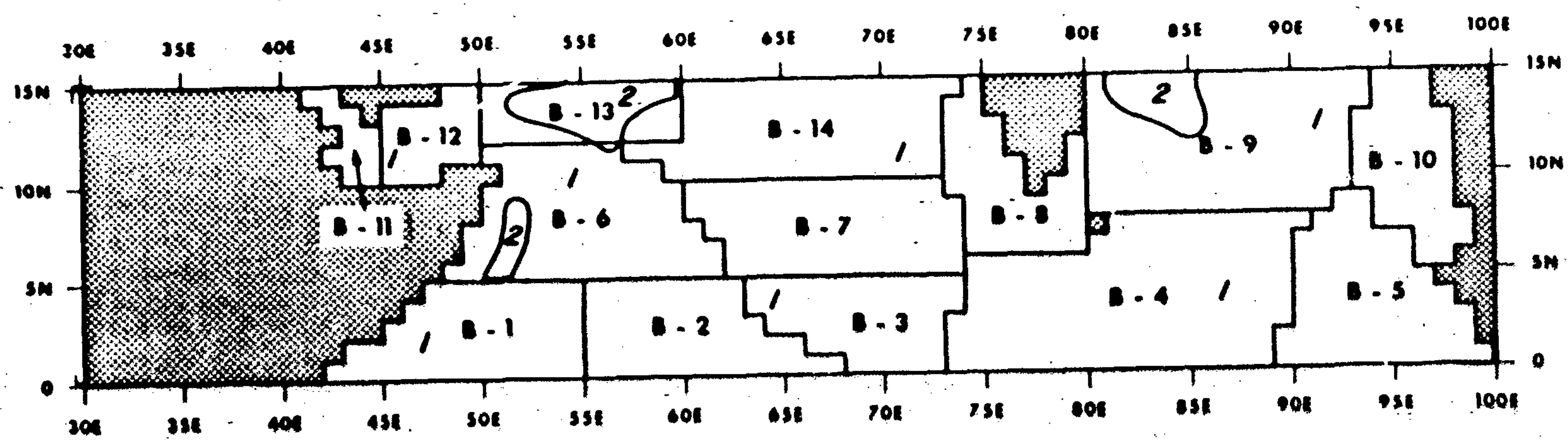
INDIAN AREA A



INDIAN AREA B

Region	Water Mass Name	1200 (°C) Min	1200 (°C) Max	[illegible] (°C) Min	[illegible] (°C) Max	Position	Freq. (%)
B1	N.W. SOMALI COLD	12	16			1	91
	N.W. SOMALI WARM	16	22			2	9
B2	N.W. SOMALI	12	19			1	100
B3	ARABIAN	[illegible]	[illegible]			1	100
B4	MID-INDIAN COLD	10	14.5			1	82
	MID-INDIAN WARM	14.5	19			2	18
B5	EAST INDIAN	10	17			1	100
B6	NORTH SOMALI COLD	12	16			1	74
	NORTH SOMALI WARM	16	22			2	26
B7	ARABIAN	13	19			1	100
B8	CEYLON	12	18			1	100
B9	NORTH INDIAN COLD	11	[illegible]			1	76
	NORTH INDIAN WARM	15	23			2	24
B10	ANDAMAN	10	17			1	100
B11	WEST ADEN	12	[illegible]			1	100
B12	EAST ADEN	12	18			1	100
B13	YEMEN COLD	12	16			1	60
	YEMEN WARM	16	21			2	40
B14	ARABIAN	13	19			1	100

INDIAN AREA B

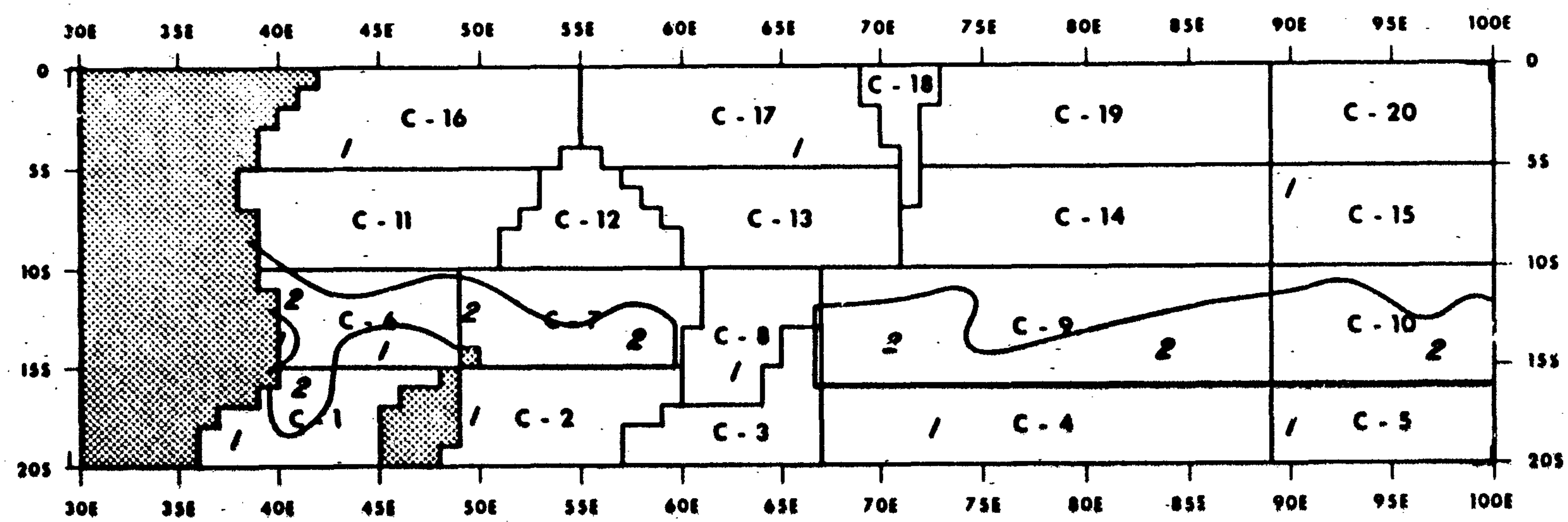


INDIAN AREA C

Region	Water Mass Name	T200 (°C) Min	T200 (°C) Max	DT (°C) Min	DT (°C) Max	Position	Freq. (%)
C1	S. MOZAMBIQUE COLD	11	17			1	30
	S. MOZAMBIQUE WARM	17	22			2	70
C2	S. MASCARENE	15	22			1	100
C3	MAURITIUS	14	22			1	100
C4	SOUTH INDIAN	15	22			1	100
C5	SOUTH WHARTON	14	21			1	100
C6	N. MOZAMBIQUE COLD	13	17			1	50
	N. MOZAMBIQUE WARM	17	23			2	50
C7	CENTRAL MASCARENE COLD	10	15			1	44
	CENTRAL MASCARENE WARM	15	20			2	56
C8	SOUTH SOMALI	13	20			1	100
C9	SOUTH INDIAN COLD	10	15			1	60
	SOUTH INDIAN WARM	15	22			2	40
C10	WHARTON COLD	10	15			1	42
	WHARTON WARM	15	22			2	58

Region	Water Mass Name	T200 (°C) Min	T200 (°C) Max	DT (°C) Min	DT (°C) Max	Position	Freq. (%)
C11	WEST SOMALI	11	18			1	100
C12	NORTH MASCARENE	11	18			1	100
C13	EAST SOMALI	11	18			1	100
C14	MID INDIAN	11	18			1	100
C15	EAST INDIAN COLD	10	14			1	84
	EAST INDIAN WARM	14	20			2	16
C16	N.W. SOMALI	10	18			1	100
C17	N.W. SOMALI	10	18			1	100
C18	ARABIAN	12	18			1	100
C19	MID INDIAN COLD	10	14.5			1	83
	MID INDIAN WARM	14.5	19.0			2	17
C20	EAST INDIAN COLD	10	14			1	84
	EAST INDIAN WARM	14	20			2	16

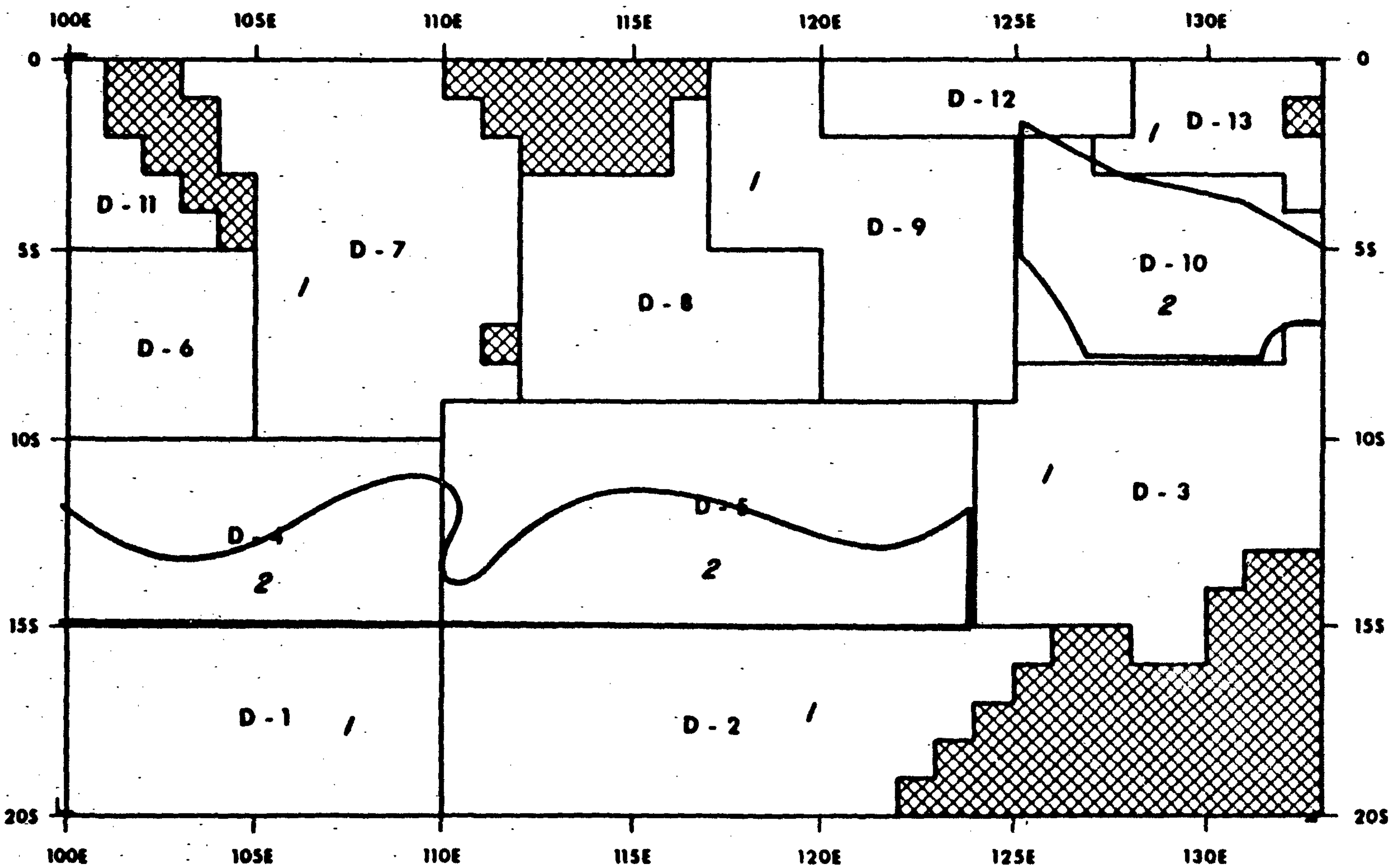
INDIAN AREA C



INDIAN AREA D

Region	Water Mass Name	T200 (°C) Min	T200 (°C) Max	DT (°C) Min	DT (°C) Max	Position	Freq. (%)
D1	SOUTH WHARTON	14	21			1	100
D2	AUSSIE WARM	13	22			1	100
D3	TIMOR	11	19			1	100
D4	WHARTON COLD	9	15			1	56
	WHARTON WARM	15	22			2	44
D5	AUSSIE COLD	9	15			1	61
	AUSSIE WARM	15	21			2	39
D6	E. INDIAN COLD	10	14			1	81
	E. INDIAN WARM	14	20			2	19
D7	SUNDA	8	18			1	100
D8	S. JAVA	9	19			1	100
D9	MAKASSAR/FLORES	11	19			1	100
D10	BANDA COLD	10	15			1	36
	BANDA WARM	15	20			2	64
D11	E. CHINA COLD	10	14			1	88
	E. CHINA WARM	14	20			2	12
D12	MOLUCCA	12	21			1	100
D13	CERAM	13	22			1	100

INDIAN AREA B



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2. GOVT ACCESSION NO.: AD-A085 000
3. RECIPIENT'S CATALOG NUMBER:
4. TITLE (and Subtitle): THE ICAPS WATER MASS HISTORY FILE
5. TYPE OF REPORT & PERIOD COVERED: Final Report
6. PERFORMING ORG. REPORT NUMBER:
7. AUTHOR(s): Alvan Fisher, Jr.
8. CONTRACT OR GRANT NUMBER(s):
9. PERFORMING ORGANIZATION NAME AND ADDRESS: U. S. Naval Oceanographic Office, NSTL Station, Bay St. Louis, MS 39522
10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS:
11. CONTROLLING OFFICE NAME AND ADDRESS: U. S. Naval Oceanographic Office, NSTL Station, Bay St. Louis, MS 39522
12. REPORT DATE: ~~April~~ 1978
13. NUMBER OF PAGES: 61 (Incl 4 appendixes)
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office):
15. SECURITY CLASS. (of this report): UNCLASSIFIED
15a. DECLASSIFICATION/DOWNGRADING SCHEDULE: N/A
16. DISTRIBUTION STATEMENT (of this Report): Approved for public release, distribution unlimited.
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report):
18. SUPPLEMENTARY NOTES:
19. KEY WORDS (Continue on reverse side if necessary and identify by block number):
ICAPS
On-scene oceanographic prediction
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Water masses

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A new Integrated Command Antisubmarine Warfare Prediction System (ICAPS) data file based on the near-surface water masses of the Northern Hemisphere and the Indian Ocean is discussed. The most attractive feature of the water mass file is that the characteristics of the input bathythermogram will objectively determine the proper deep history for computation of the surface-to-bottom sound speed profile. A second feature is the adjustment of salinity in the presence of temperature inversions (sound channels) to maintain a stable water column. Evaluation of the water mass file using salinity-temperature-depth (STD) data shows that it is improved over the file presently used by ICAPS. The new file is described and the temperature criteria used to define water masses in each area are given.

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